၂၀၁၉ ခုနှစ်၊ မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆုရ ပါရဂူကျမ်း

oawoevyie; tp&icpmrsm;

2019 Calendar Year, Myanmar Academy of Arts and Science Award Winning Doctoral Dissertation

Research Reports

၂၀၂၃ ဇန်နဝါရီလ

2023 January

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အမှာစာ

ပညာရေးသည် ပုဂ္ဂိုလ် တစ်ဦးချင်းနှင့်အတူ မိသားစု တစ်စုလုံး၏ လူမှုစီးပွား ဘဝကို မြှင့်တင်ပေး ရုံသာမက၊ လူမှုအစုအဖွဲ့များအကြား၌ လူမှုဆက်ဆံရေးကို ပြေလည်စေခြင်းဖြင့် ပြည်တွင်း ငြိမ်းချမ်းရေးမှသည် နိုင်ငံတော်၏ စီးပွားရေးနှင့် အမျိုးသား စည်းလုံးညီညွတ်ရေး အစရှိသည့် လုပ်ငန်းတို့ကို ဖွံ့ဖြိုးတိုးတက်စေရာတွင် အဓိက အခန်းကဏ္ဍမှ ပါဝင်နေပါသည်။

မြန်မာနိုင်ငံ၏ ပညာရေးအဆင့်အတန်းကို နိုင်ငံတော်က အာဆီယံ အဖွဲ့ဝင် နိုင်ငံများ၏ အဆင့်အတန်း မှသည် ကမ္ဘာ့ဖွံ့ဖြိုးပြီးနိုင်ငံကြီးများ၏ အဆင့်အတန်း မီသည်အထိ မြှင့်တင်ပေးသွားရန် ရည်မှန်းထားပါသည်။ ပညာရေးဝန်ကြီးဌာနအနေဖြင့် ဤရည်မှန်းချက် အထမြောက်စေရေးအတွက် အမျိုးသားပညာရေး မဟာဗျူဟာ စီမံကိန်း (၂၀၁၇-၂၀၃၀)ကို ရေးဆွဲချမှတ်၍ အကောင်အထည်ဖော် ဆောင်ရွက်လျက် ရှိပါသည်။

အမျိုးသားပညာရေးဥပဒေကို ပြင်ဆင် သည့်ဥပဒေ (၂၀၁၅)၊ စာမျက်နှာ (၁၃)၊ ပုဒ်မ(၂၈)တွင် သုတေသန ဆောင်ရွက်မှုနှင့်စပ်လျဉ်း၍ အဆင့်မြင့်ပညာ သင်ကြားပို့ချနေသော တက္ကသိုလ်ကောလိပ်များအား သုတေသနနှင့် ပညာရပ်ဖွံ့ဖြိုးမှုကို ဦးစားပေး ဆောင်ရွက်ရမည်ဟု ပြဋ္ဌာန်းထားပါသည်။

နိုင်ငံတော်အစိုးရက မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ကို ၁၉၉၉ ခုနှစ်၊ ဩဂုတ်လ (၁၆)ရက်နေ့တွင် ဖွဲ့စည်းပေးခဲ့ပါသည်။ ဤပညာရှင်အဖွဲ့အနေဖြင့် ပညာရေးနှင့် နီးနွယ်သော လုပ်ငန်းများကို-

(က) သင်ကြားရေးနှင့်သင်ယူရေး၊

(ခ) သုတေသန လုပ်ငန်းလမ်းညွှန်မှု ပေးရေး၊

(ဂ) ပညာပြန့်ပွားရေးနှင့်ပညာဖြန့်ဖြူးရေး၊

(ဃ) ပညာရှင်များ ပြုစုပျိုးထောင်ရေးဟူ၍ လုပ်ငန်းကြီးလေးမျိုး ခွဲခြားကာ၊

ပညာရေးကဏ္ဍ၏ လိုအပ်ချက်များအရ ဦးစားပေးအစီအစဉ်အတိုင်း ပြည်တွင်းပြည်ပ ပညာရှင်များနှင့် ပူးပေါင်း ဆောင်ရွက်လျက်ရှိပါသည်။

၂၀၂၀ပြည့်နှစ်အထိ နှစ်ပေါင်းနှစ်ဆယ်အတွင်း၌ သုတေသနစာတမ်းဖတ်ပွဲများကို ပညာရှင်အဖွဲ့ စတင် ဖွဲ့စည်းချိန် ၁၉၉၉ ခုနှစ်မှစတင်၍ နှစ်စဉ် ကျင်းပ ပေးနိုင်ခဲ့ပါသည်။ ၂၀၀၅ ခုနှစ် ပဉ္စမအကြိမ် သုတေသန စာတမ်းဖတ်ပွဲမှ အစပြု၍ **အကောင်းဆုံးသုတေသနစာတမ်းဆု(Best Paper Award)**ကို ချီးမြှင့်ခဲ့ရာ၊ တစ်နှစ်ထက် တစ်နှစ် ဆုရစာတမ်းများ၏ အရေအတွက် ပိုမို၍တိုးပွားလာခဲ့ပါသည်။ ၂၀၂၀ ပြည့်နှစ်တွင် သုတေသနညီလာခံ၌ အကောင်းဆုံး သုတေသနစာတမ်းဆုရ စာတမ်းရှင် စုစုပေါင်း (၂၆)ဦး အား ဆုများ ချီးမြှင့်နိုင် ခဲ့ပါသည်။

သုတေသနလုပ်ငန်းများပေါ် အခြေခံ၍ ပါရဂူကျမ်းပြုစုခဲ့သော ပညာရှင်များအနက် ထူးချွန်သူ များအား ရွေးချယ်၍ **မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆု** ချီးမြှင့်ရန် ပညာရှင်အဖွဲ့အနေဖြင့် ကြိုးပမ်းခဲ့ပါသည်။ ၂၀၁၉ ခုနှစ် အတွင်း၌ ပါရဂူဘွဲ့ ရရှိခဲ့သူများအား ပြိုင်ပွဲဝင်ရန် ပညာရှင်အဖွဲ့မှ ဖိတ်ခေါ်ခဲ့ရာ၊ ပါရဂူဘွဲ့ရ ပညာရှင် စုစုပေါင်း (၃၃)ဦး ယှဉ်ပြိုင်ခဲ့ကြပါသည်။ ဘာသာရပ်တိုင်း၌ ပညာရှင်အဖွဲ့ဆု၏ အရေအတွက်နှင့်အတူ ဆုငွေ၏ ပမာဏကိုလည်း တိုးမြှင့်ပေးအပ်သွားရန် အဖွဲ့က ကြိုးစားနေပါသည်။ ပညာရှင်အဖွဲ့ဆု အစပျိုးချိန်တွင် ပညာရှင် အဖွဲ့၊ ထွန်းဖောင်ဒေးရှင်း၊ သီရိမွန် ဖောင်ဒေးရှင်းတို့၏ လှူဒါန်းငွေဖြင့် ဆုများကိုချီးမြှင့်ခဲ့ပါသည်။ ယခုအခါ

(က) မြန်မာနိုင်ငံစာစစ်အဖွဲ့ ဥက္ကဋ္ဌ(ဦးမ်း) ဦးမောင်မောင်စိန်နှင့်ဇနီး ဒေါ်ခင်မာမာတို့က ရန်ကုန်တက္ကသိုလ် ပါမောက္ခချုပ် ဆရာကြီး ဒေါက်တာ ထင်အောင် အထိမ်းအမှတ်အဖြစ် လှူဒါန်းငွေ၊

(ခ) ရန်ကုန်စီးပွားရေးတက္ကသိုလ်မှ ဆရာကြီး ဦးဝီလျံပေါ အထိမ်းအမှတ်အဖြစ် လှူဒါန်းငွေ၊

(ဂ) ရန်ကုန်တက္ကသိုလ် မြန်မာစာဌာနမှ မြန်မာစာဌာန တည်ထောင်ခဲ့သည့် (၇၅) နှစ်ပြည့် အထိမ်းအမှတ်အဖြစ် လှူဒါန်းငွေနှင့်

(ဃ) ဆရာမကြီး ဒေါ်ခင်သိန်း၊ ပါမောက္ခ(ငြိမ်း)၊ အရှေ့တိုင်းပညာဌာနမှ ရန်ကုန်တက္ကသိုလ် ပါမောက္ခချုပ် ဆရာကြီး ဦးဖေမောင်တင် အထိမ်းအမှတ် အဖြစ် လှူဒါန်းငွေ

များကို ဘဏ်တွင် ပဒေသာပင်အဖြစ် အပ်နှံကာတိုးပွားလာသည့် ဘဏ်အတိုးငွေများဖြင့် ဆုငွေကို ချီးမြှင့်လျက် ရှိပါသည်။

ထိုလှူဒါန်းငွေများအပြင် သုတေသနစာတမ်းဆုနှင့် ပညာရှင်အဖွဲ့ဆု အတွက် ၂၀၁၆ ခုနှစ်၊ (၁၆)ကြိမ်မြောက် သုတေသနစာတမ်းဖတ်ပွဲမှ အစပြု၍ ပညာရေးဝန်ကြီးဌာနမှ ဆုငွေများကို ထုတ်ပေးနေပါသည်။

တက္ကသိုလ်၊ ကောလိပ်များမှ ဆရာ ဆရာမများ၏ စွမ်းဆောင်ရည်သည် တစ်ဦးချင်း၏ ပညာအရည်အချင်းနှင့်အတူ မိမိတတ်ကျွမ်းသော ဘာသာရပ်၌ မိမိဆောင်ရွက်ခဲ့သော သုတေသနလုပ်ငန်းများမှ ရရှိထားသည့် အတွေ့အကြုံများ အပေါ်တွင်လည်း အများအပြား မူတည်နေပါသည်။

အကြိမ် (၂၀) မြောက် သုတေသနညီလာခံတွင် ၂၀၁၉ ပြက္ခဒိန်နှစ် အတွက် မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံ ပညာရှင် အဖွဲ့ဆု ရရှိခဲ့သည့် သုတေသနလုပ်ငန်း အစီရင်ခံစာများမှာ အောက်ပါအတိုင်း ဖြစ်ပါသည် -

(က) ဝိဇ္ဇာပညာရပ်

- **စိတ်ပညာ ဘာသာရပ်**

  Facebook Use, Attitude Toward Facebook, Self-Esteem and College Adjustment among Monywa University Students

- **နိုင်ငံတကာဆက်ဆံရေးပညာ ဘာသာရပ်**

  Mangrove Conservation Efforts in Myanmar: Ayeyarwady and Rakhine

- **မြန်မာစာ ဘာသာရပ်**

  မြန်မာဘာသာစကားရှိ နောက်လိုက် ပစ္စည်းများ

(ခ) သိပ္ပံပညာရပ်

- **ဘူမိဗေဒ ဘာသာရပ်**

  Preventive Measures for the Landslides and Hillside Development along the Thazi-Taunggyi Car-Road between Yinmabin and Kalaw

- **အဏ္ဏဝါသိပ္ပံ ဘာသာရပ်**

  Biology and Culture of Green Mussel *Perna Viridis* (Linnaeus, 1758) from Ye Estuary in Mon State

- **ကုန်ထုတ်ဓာတုဗေဒ ဘာသာရပ်**

  Isolation of Protein from Different Indigenous Beans and Its Utilization in Food Industries

- **ရူပဗေဒ ဘာသာရပ်**

  Preparation and Characterization of SnO_2 Nanofiber and Thin Film Photoelectrodes for Dye Sensitized Soler Cells

(၈) လူမှုရေးပညာရပ်

- **စာရင်းအင်းပညာ ဘာသာရပ်**

  Modelling Residents' Support for Tourism Development with Special Reference to Bagan-Nyaung Oo Area, Myanmar

- **ပညာရေးသဘောတရား ဘာသာရပ်**

  An Analytical Study of Parenting Knowledge and Practices

- **ဥပဒေပညာ ဘာသာရပ်**

  Legal Study on the Interpretation and Implementation of Trips Agreement

ပါရဂူကျမ်းဆိုင်ရာ သုတေသနပြုစုသူများ အပါအဝင် တက္ကသိုလ် ဆရာ၊ ဆရာမများနှင့် အများပြည်သူတို့ လေ့လာခွင့် ရရှိစေရန် ရည်ရွယ်၍ ဤစာအုပ်ကို ပုံနှိပ်ထုတ်ဝေ ဖြန့်ချိခြင်း ဖြစ်ပါသည်။

ဒေါက်တာသက်လွင်

ဥက္ကဋ္ဌ

မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့

FOREWORD

It cannot be denied that education plays a vital role in increasing the family income, promoting the general well-being of an individual as well as that of his family, invigorating the cooperative spirit of communities, developing the country's economy, and last but not least, contributing positively to all endeavours for national unity and peace.

Our country has been engaged vigorously in the task of enhancing the quality of education with a view to raising it from the current ASEAN standard to that of the developed countries. In order to achieve that objective, the Ministry of Education drew up the National Education Strategic Plan 2017-2030 and has since been implementing the projects under that plan.

Section 28 on page 13 of The Republic of the Union of Myanmar National Education Law (2015) stipulates that all colleges and universities under the Department of Higher Education give priority to carrying out research programmes and education development.

The Myanmar Academy of Arts and Science, instituted in 1999, is fully committed to:

1) The dissemination of modern methods and techniques of teaching and learning,
2) The promotion of research and providing guidelines for research programmes and projects,
3) The dissemination and propagation of knowledge and expertise among the general public, and
4) The promotion of measures aimed at the generation and proliferation of competent researchers, academicians and Technocrats.

Ever since its institution, the Academy has endeavoured to meet those commitments through national and international networks.

From 2000, a year after its inception, the Academy has been holding Annual Research Conferences, and from the Fifth Annual Research Conference onwards, the Academy commenced bestowing the Best Paper Award. The number of quality research papers has increased from year to year; it is most gratifying to find that a total of 26 researchers won the Best Paper Award at the 2020 Research Conference.

In 2006, the Academy initiated a nationwide Contest of Research Reports of doctoral theses in various fields of study, with a view to bestow the Myanmar Academy of Arts and Science Award to the best researcher of the year; there was a total of 120 contestants. Currently, the Academy is making an all-out effort to raise the prize money in order that there would be more and more research aspirants in every field of study. The initial Academy of Arts and Science Awards were borne by the Academy, the Tun Foundation and the Thiri-mon Foundation. Today, donations made by:

a) Retired President of the Board of Examinations U Maung Maung Sein and his spouse in commemoration of Sayagyi Dr Htin Aung, Rector of Rangoon University

b) Yangon University of Economics in commemoration of Sayagyi Saw William Paw

c) Department of Myanmar, University of Yangon, in commemoration of its 75th anniversary, and

d) Sayamagyi Daw Khin Thein, Retired Professor of the Department of Oriental Studies, University of Yangon in commemoration of Sayagyi U Pe Maung Tin

have been established as a Foundation and the bank interest accrued upon it is used as the means to meet the expenses of the awards.

In addition, since 2017, the Ministry of Education has been sponsoring the Best Paper Award as well as the Myanmar Academy of Arts and Science Award.

The ability of an academician is commensurate not only with his or her educational accomplishments but also with the knowledge he or she gains from the research projects he or she carries out.

The best research report of doctoral theses for the year 2018 are:

(a) Arts

- **Psychology**

  Facebook Use, Attitude Toward Facebook, Self-Esteem and College Adjustment among Monywa University Students

- **International Relations**

  Mangrove Conservation Efforts in Myanmar: Ayeyarwady and Rakhine

- **Myanmar**

  မြန်မာဘာသာစကားရှိ နောက်လိုက် ပစ္စည်းများ

(b) Physical Sciences

- **Geology**

  Preventive Measures for the Landslides and Hillside Development along the Thazi-Taunggyi Car-Road between Yinmabin and Kalaw

- **Marine Science**

  Biology and Culture of Green Mussel *Perna Viridis* (Linnaeus, 1758) from Ye Estuary in Mon State

- **Industrial Chemistry**

  Isolation of Protein from Different Indigenous Beans and Its Utilization in Food Industries

- **Physics**

  Preparation and Characterization of SnO_2 Nanofiber and Thin Film Photoelectrodes for Dye Sensitized Soler Cells

(c) Social Science

- **Statistics**

  Modelling Residents' Support for Tourism Development with Special Reference to Bagan-Nyaung Oo Area, Myanmar

- **Educational Theory**

  An Analytical Study of Parenting Knowledge and Practices

- **Law**

  Legal Study on the Interpretation and Implementation of Trips Agreement

The Myanmar Academy of Arts and Science is delighted to publish this book for the benefit of the Contestants concerned, the academicians in the universities and colleges as well as the general public.

President

Myanmar Academy of Arts and Science

၁။ ။ ၂၀၁၉ ခုနှစ်၊ မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆုနှင့် နှီးနွယ်သော ပါရဂူကျမ်း သုတေသန လုပ်ငန်း အစီရင်ခံစာ ရွေးချယ်မှု

ရည်ရွယ်ချက်

၁။ မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့၊ အခြေခံစည်းမျဉ်းများ အခန်း(၂)၊ အပိုဒ် (၃) တွင် ပါရှိသည့် ရည်ရွယ်ချက် (၅)ရပ်အနက် –

(၁) နိုင်ငံတော်ကို အကျိုးပြုမည့် သုတေသနလုပ်ငန်းများ ဆောင်ရွက်ရန်နှင့်

(၂) နိုင်ငံတော်ကိုအကျိုးပြုမည့် ဝိဇ္ဇာသိပ္ပံပညာရှင်များ မွေးထုတ်နိုင်ရေးအတွက် စီမံ ဆောင်ရွက်ရန်၊

တို့ပါရှိပါသည်။

ဆုပေးအပ်ချီးမြှင့်မှု

၂။ မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အမှုဆောင်အဖွဲ့၏ စတုတ္ထလုပ်ငန်းအဖွဲ့ဖြစ်သော ပညာရှင်ပြုစု ပျိုးထောင်ရေးအဖွဲ့က ချမှတ်ထားသည့် လုပ်ငန်းစဉ် (၁၄)ရပ်အနက်၊ လုပ်ငန်းစဉ် (၄)တွင် ဝိဇ္ဇာနှင့်သိပ္ပံ ပညာရပ်ဆိုင်ရာ ကျမ်းများ၊ စာအုပ်များအနက်မှ အကောင်းဆုံးကို **"ဝိဇ္ဇာနှင့်သိပ္ပံဘာသာ စာပေဆု"** ချီးမြှင့်ရန် ပါရှိပါသည်။ အဆိုပါဆုကို မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆု အနေဖြင့် ထိုက်တန်စွာ ပေးအပ် ချီးမြှင့်ရန် ရည်ရွယ်ခြင်း ဖြစ်ပါသည်။

စံသတ်မှတ်ချက်

၃။ "**မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆု**" ရွေးချယ်ရေးအတွက် ယေဘုယျ သတ်မှတ်ထားသော စံများမှာ အောက်ပါအတိုင်းဖြစ်ပါသည်-

(က) ပြည်ထောင်စုသမ္မတ မြန်မာနိုင်ငံတော်၊ ပညာရေးဝန်ကြီးဌာနအောက်ရှိ တက္ကသိုလ်များတွင် သတ်မှတ်ထားသည့်ခုနှစ်အတွင်း တင်သွင်း လက်ခံခဲ့သော ပါရဂူကျမ်း ဖြစ်ရမည်။

(ခ) နိုင်ငံတော်နှင့်လူမျိုးအတွက် အသိဉာဏ် တိုးတက်စေရန်(သို့မဟုတ်) အသိဉာဏ်ကို အသုံးချ နိုင်စေရန် (သို့မဟုတ်) သက်ဆိုင်ရာ ဘာသာရပ် ဖွံ့ဖြိုးတိုးတက်စေရန် ထူးခြားစွာ အကျိုးပြုစေ နိုင်သည့် ပါရဂူကျမ်းဖြစ်ရမည်။

(ဂ) **"မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင် အဖွဲ့ဆု"** အတွက် မိမိ၏ပါရဂူကျမ်းကို အခြေခံ၍ စာမျက်နှာ (၂၀-၃၀) ခန့်ရှိ သုတေသနလုပ်ငန်း အစီရင်ခံစာ (Research Report) ပြုစု ရေးသားတင်သွင်း ရမည်။

(ဃ) မူပိုင်ကိစ္စနှင့်စပ်လျဉ်း၍ ရှင်းရှင်းလင်းလင်း ရှိစေရမည်။

(ဂ) ၂၀၁၉ ခုနှစ် အတွင်း ပညာရေးဝန်ကြီးဌာန အောက်ရှိ တက္ကသိုလ်များတွင် ထုတ်ပြန်သော **ပါရဂူကျမ်း အောင်စာရင်းတွင်** ပါရှိကြောင်း **သက်ဆိုင်ရာ ပါရဂူဘွဲ့ ရယူခဲ့သည့် တက္ကသိုလ်၏ မော်ကွန်းထိန်းထံ**မှ ထောက်ခံချက် ပါရှိရမည်။

ရွေးချယ်ရေးအဖွဲ့ ဖွဲ့စည်းခြင်း

၄။ **"မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆု"** ရွေးချယ်ရေးအဖွဲ့များကို အကဲဖြတ်နိုင်မည့် ပညာရှင်များဖြင့် ဖွဲ့စည်း၍ ရွေးချယ်ခြင်းဖြစ်ပါသည်။

၅။ သုတေသနလုပ်ငန်းအစီရင်ခံစာကို အောက်ဖော်ပြပါ မူ (၅)ရပ်အပေါ်တွင် အခြေခံ၍ အကဲဖြတ် ရွေးချယ်ပါသည်-

(က) သုတေသနလုပ်ငန်းသည် နိုင်ငံတော်အတွက် မည်၍ မည်မျှအကျိုးပြုခြင်း (Contribution to the National Interest)

(ခ) သုတေသနလုပ်ငန်းသည် ပင်ကို ဖြစ်ခြင်း (Originality)

(ဂ) သုတေသနလုပ်ငန်းကို စနစ်တကျ/သိပ္ပံနည်းကျ ဆောင်ရွက်ထားခြင်း (Systematic/ Scientific Approach)

(ဃ) သုတေသနလုပ်ငန်းသည် ဘာသာရပ်အတွက် မည်သည့်အတိုင်းအတာအထိ အကျိုးပြု နိုင်ခြင်း (Contribution to the Subject)

(င) သုတေသနအစီရင်ခံစာ ဖတ်ကြား တင်ပြပုံ စနစ်ကျနခြင်း (Presentation, Format and Style)

ဆုချီးမြှင့်ခြင်း

၆။ "မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆု" ချီးမြှင့်ပေးအပ်ရာတွင် -

(က) အဆိုပြုလာသော ဝိဇ္ဇာဘာသာရပ်ဆိုင်ရာ ပါရဂူကျမ်းများအနက်၊ အကောင်းဆုံး ဝိဇ္ဇာပညာရပ် ပါရဂူကျမ်းနှင့် သုတေသနလုပ်ငန်းအစီရင်ခံစာ ပြုစုသောပုဂ္ဂိုလ်အား ပညာရှင်အဖွဲ့၏ ဆုကို **ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆု (ဝိဇ္ဇာပညာရပ်)** ဟူ၍ လည်းကောင်း၊

(ခ) အဆိုပြုလာသော သိပ္ပံဘာသာရပ်ဆိုင်ရာ ပါရဂူကျမ်းများအနက်၊ အကောင်းဆုံး သိပ္ပံပညာရပ် ပါရဂူကျမ်းနှင့် သုတေသနလုပ်ငန်း အစီရင်ခံစာ ပြုစုသော ပုဂ္ဂိုလ်အား ပညာရှင်အဖွဲ့၏ဆုကို **ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆု (သိပ္ပံပညာရပ်)**ဟူ၍ လည်းကောင်း၊

(ဂ) အဆိုပြုလာသော လူမှုရေး(စီးပွါးရေးပညာ၊ သင်ပြမှု/သင်ယူမှုပညာ၊ ဥပဒေပညာ၊ ဘာသာစကားစသည့်) ဘာသာရပ်ဆိုင်ရာ ပါရဂူကျမ်းများအနက်၊ အကောင်းဆုံး လူမှုရေးပညာရပ် ပါရဂူကျမ်း

နှင့် သုတေသနလုပ်ငန်းအစီရင်ခံစာ ပြုစုသောပုဂ္ဂိုလ်အား ပညာရှင်အဖွဲ့၏ ဆုကို **ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင် အဖွဲ့ဆု (လူမှုရေးပညာရပ်)**ဟူ၍ လည်းကောင်း၊

ဆု (၃)မျိုး ခွဲခြား၍ ချီးမြှင့် ပေးအပ်ခြင်း ဖြစ်ပါသည်။

မှတ်ချက် ။ ဆု တစ်ဆုစီအတွက် အကောင်းဆုံးဟု ယူဆထားသော ပါရဂူကျမ်း အကယ်၍ မရှိပါက ထိုဆုအတွက် ချီးမြှင့်မည် မဟုတ်ပါ။

၇။ ၂၀၁၉ ခုနှစ်၊ (၁၄)ကြိမ်မြောက် "**မြန်မာနိုင်ငံဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင် အဖွဲ့ဆု"**အတွက် ပြိုင်ပွဲဝင် သည့် ပါရဂူဘွဲ့ရပညာရှင် စုစုပေါင်း (၃၃)ဦး ရှိခဲ့ရာ၊ အောက်ဖော်ပြပါ (၁၀) ဦးတို့သည် **"မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင် အဖွဲ့ဆု"** ကို –

(၁) **ဝိဇ္ဇာပညာရပ်**မှ စိတ်ပညာ ဘာသာရပ်တွင် ဒေါက်တာ ခင်နွယ်ဆင့်၊ နိုင်ငံတကာဆက်ဆံရေး ပညာ ဘာသာရပ်တွင် ဒေါက်တာ ဟိန်းမြတ်သူ၊ မြန်မာစာ ဘာသာရပ်တွင် ဒေါက်တာ ထက်ထက်စိန်ဝင်း တို့က လည်းကောင်း၊

(၂) **သိပ္ပံပညာရပ်**မှ ဘူမိဗေဒ ဘာသာရပ်တွင် ဒေါက်တာ အောင်ကျော်မြတ်၊ အဏ္ဏဝါသိပ္ပံ ဘာသာရပ်တွင် ဒေါက်တာ ဝင်းဝင်းနွယ်၊ ကုန်ထုတ်ဓာတုဗေဒ ဘာသာရပ်တွင် ဒေါက်တာ ဇာဇာဦး နှင့် ရူပဗေဒ ဘာသာရပ်တွင် ဒေါက်တာ ဇေယျာပြည့်ဖြိုးအောင်တို့က လည်းကောင်း၊

(၃) **လူမှုရေးပညာရပ်**မှ စီးပွားရေး ဘာသာရပ်တွင် ဒေါက်တာ လှိုင်လှိုင်မိုး၊ ပညာရေးသဘောတရား ဘာသာရပ်တွင် ဒေါက်တာ ခိုင်ရည်မွန်နှင့် ဥပဒေပညာ ဘာသာရပ်တွင် ဒေါက်တာ ဖြူဖြူသင်းက လည်းကောင်း၊

အသီးသီး ရရှိကြပါသည်။

၈။ အဆိုပါ **"မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆု"** ချီးမြှင့်ရာ၌ ပါရဂူကျမ်းနှင့် သုတေသနလုပ်ငန်း အစီရင်ခံစာများအပေါ်တွင် အခြေပြု၍ အရွေးချယ်ခံရသည့်အကြောင်းရင်းတို့ကို အောက်တွင် အကျဉ်းချုပ်၍ ဖော်ပြထားပါသည်-

(၈-၁) ဝိဇ္ဇာ ပညာရပ် (၁) - **စိတ်ပညာ ဘာသာရပ်**
ဒေါက်တာ ခင်နွယ်ဆင့်
ကထိက၊ စိတ်ပညာဌာန၊
ရတနာပုံ တက္ကသိုလ်

ကျမ်းခေါင်းစဉ် - **Facebook Use, Attitude Toward Facebook, Self-Esteem and College Adjustment among Monywa University Students**

(က) **ဝိဇ္ဇာပညာရပ်**တွင် ပညာရှင်အဖွဲ့ ဆုရသူ သုံးဦးအနက် **ဒေါက်တာ ခင်နွယ်ဆင့်**သည် ၂၀၁၉ ခုနှစ်တွင် မန္တလေးတက္ကသိုလ်မှ **စိတ်ပညာဘာသာရပ်** ဖြင့် ပါရဂူဘွဲ့ရရှိခဲ့သူ ဖြစ်ပါသည်။

(ခ) ဒေါက်တာ ခင်နွယ်ဆင့်သည် –

- ဤပါရဂူကျမ်း သုတေသနသည် နိုင်ငံတော် အတွက် အကျိုးပြုနိုင်၍ စိတ်ပညာ ဘာသာရပ်အတွက် ပထမဦးစွာ တင်ပြထားခြင်း၊
- သုတေသနပြုရာတွင် သုတေသနဆိုင်ရာ လုပ်ငန်းအဆင့်ဆင့်များကို လိုက်နာ ဆောင်ရွက်၍ စာရင်းအင်းပညာဖြင့်လည်း ရလဒ်များကို စိစစ်တင်ပြထားခြင်း၊
- Facebook ကို လူငယ် လူငယ်များ စိတ်ဝင်စားမှု အပြုအမူနှင့် သဘောထားများကို ဖော်ပြ၍ ဆွေးနွေးထားသည့်အတွက် စိတ်ပညာဘာသာရပ်တွင် အသုံးဝင်သော လေ့လာမှုခြင်း၊

တို့ကြောင့် **ဝိဇ္ဇာပညာရပ်ဆိုင်ရာ** မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင် အဖွဲ့ဆုအတွက် ရွေးချယ်ခဲ့ခြင်း ဖြစ်ပါသည်။

(၈-၂) ဝိဇ္ဇာ ပညာရပ် (၁) - **နိုင်ငံတကာဆက်ဆံရေးပညာ ဘာသာရပ်**
ဒေါက်တာ ဟိန်းမြတ်သူ
နည်းပြ၊ နိုင်ငံတကာဆက်ဆံရေးပညာဌာန၊
ရန်ကုန်တက္ကသိုလ်

ကျမ်းခေါင်းစဉ် - Mangrove Conservation Efforts in Myanmar: Ayeyarwady and Rakhine

(က) **ဝိဇ္ဇာပညာရပ်**တွင် ပညာရှင်အဖွဲ့ဆုရသူ သုံးဦးအနက် **ဒေါက်တာ ဟိန်းမြတ်သူ**သည် ၂၀၁၉ ခုနှစ် တွင် ရန်ကုန်တက္ကသိုလ်မှ **နိုင်ငံတကာဆက်ဆံရေးဘာသာရပ်** ဖြင့် ပါရဂူဘွဲ့ ရရှိခဲ့သူ ဖြစ်ပါသည်။

(ခ) ဒေါက်တာ ဟိန်းမြတ်သူသည် –

- ဤပါရဂူကျမ်း သုတေသနသည် နိုင်ငံတကာဆက်ဆံရေးပညာ Multidisciplinary နယ်ပယ်ကို အထောက်အကူပြုပြီး နိုင်ငံအတွက် အကျိုးပြု သုတေသနကျမ်း ဖြစ်ခြင်း၊
- လေ့လာချဉ်းကပ် တင်ဆက်ပုံ ကောင်းမွန်ပြီး သင်ကြားရေးအတွက် အထောက် အကူ ပြုခြင်း၊

တို့ကြောင့် **ဝိဇ္ဇာပညာရပ်ဆိုင်ရာ** မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင် အဖွဲ့ဆုအတွက် ရွေးချယ်ခဲ့ခြင်း ဖြစ်ပါသည်။

(၈-၃)ဝိဇ္ဇာ ပညာရပ်(၃) - **မြန်မာစာ ဘာသာရပ်**
ဒေါက်တာ ထက်ထက်စိန်ဝင်း
ကထိက၊ မြန်မာစာဌာန၊
ရန်ကုန်ပညာရေးတက္ကသိုလ်

ကျမ်းခေါင်းစဉ် - **မြန်မာဘာသာစကားရှိ နောက်လိုက် ပစ္စည်းများ**

(က) **ဝိဇ္ဇာပညာရပ်**တွင် ပညာရှင်အဖွဲ့ဆုရသူ သုံးဦးအနက် **ဒေါက်တာ ထက်ထက်စိန်ဝင်း** သည် ၂၀၁၉ ခုနှစ်တွင် မန္တလေးတက္ကသိုလ်မှ မြန်မာစာ ဘာသာရပ်ဖြင့် ပါရဂူဘွဲ့ ရရှိခဲ့သူ ဖြစ်ပါသည်။

(ခ) ဒေါက်တာ ထက်ထက်စိန်ဝင်း၏ သုတေသနသည် –

- မြန်မာစာ ရေးသားရာ၌ အရေးပါသည့် မြန်မာသဒ္ဒါမှ နောက်လိုက်ပစ္စည်း အကြောင်းကို သုတေသနပြု၍ ပြည့်စုံစွာ တင်ပြထားသောကြောင့် မြန်မာဘာသာ စကား၏ အခန်း ကဏ္ဍာတစ်ရပ် ကို ဖြည့်စွက်ပေးရာရောက်ခြင်း၊

- မြန်မာဘာသာစကားရှိ နောက်လိုက်ပစ္စည်းများအကြောင်းကို ကျယ်ကျယ်ပြန့်ပြန့် လေ့လာပြီး အပြောနှင့်အရေး သုံးစကားများကို အကိုးအထောက်ပြုကာ ရှင်းလင်း၊ ခိုင်မာအောင် တင်ပြထားသည့် ကိုယ်ပိုင် သုတေသနဖြစ်ခြင်း၊
- ဘာသာဗေဒနည်းစနစ်များဖြင့် စနစ်တကျ သုတေသနပြု၍ ဖော်ထုတ်တင်ပြခြင်း၊
- မြန်မာဘာသာစကားကို ပြောဆို ရေးသားရာ၌ မှန်မှန် ကန်ကန်နှင့် ဆိုလိုရင်း အနက် တိကျပေါ်လွင်အောင် ပြောဆိုရေးသားနိုင်ခြင်း၊ သင်ကြားရေးတွင် အထောက်အကူ ပြုနိုင်ခြင်းစသည် ဘာသာရပ်ဆိုင်ရာ အကျိုးတရားများရရှိနိုင်ခြင်း၊
- သုတေသနကျမ်းနှင့် အစီရင်ခံစာမှာ ကျမ်းခေါင်းစဉ်နှင့်ဆီလျော်ခြင်း၊ သုတေသနပြုပုံ စနစ်ကျခြင်း၊ ကျမ်းကိုးများ ပြည့်စုံခြင်း၊

တို့ကြောင့် **ဝိဇ္ဇာပညာရပ်ဆိုင်ရာ** မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆု အတွက် ရွေးချယ်ခဲ့ခြင်း ဖြစ်ပါသည်။

(၈-၄)သိပ္ပံ ပညာရပ်(၁) - **ဘူမိဗေဒ ဘာသာရပ်**

ဒေါက်တာ အောင်ကျော်မြတ်
တွဲဖက်ပါမောက္ခ၊ ဘူမိဗေဒဌာန
ရန်ကုန်တက္ကသိုလ်

ကျမ်းခေါင်းစဉ် - **Preventive Measures for the Landslides and Hillside Development along the Thazi-Taunggyi Car-Road between Yinmabin and Kalaw**

(က) သိပ္ပံပညာရပ်တွင် ပညာရှင်အဖွဲ့ဆုရသူ လေးဦးအနက် **ဒေါက်တာ အောင်ကျော်မြတ်** သည် ၂၀၁၉ ခုနှစ်တွင် ရန်ကုန်တက္ကသိုလ်မှ **အင်ဂျင်နီယာဘူမိဗေဒဘာသာရပ်** ဖြင့် ပါရဂူဘွဲ့ရရှိခဲ့သူ ဖြစ်ပါသည်။

(ခ) ဒေါက်တာ အောင်ကျော်မြတ်၏ သုတေသနသည် –

- သုတေသနသည် ပင်ကိုယ်ဖြစ်ပြီး မြန်မာနိုင်ငံတွင် မြေပြိုကျမှုဆိုင်ရာ Lanslide Hazard သဘာဝဘေးအန္တရာယ်ကို အစဉ်တွေ့ကြုံခဲ့ရသောလမ်းများ ဒေသတစ်ခုတွင် ဖြစ်လေ့ရှိပြီး အများပြည်သူတို့၏ အသက်အိုးအိမ်တို့ကို ကာကွယ်ရန်အတွက် ကြိုတင်ကာကွယ်ရေးစနစ်များ ရေရှည်ဖွံ့ဖြိုးတိုးတက်ရေးတို့ကိုပါ ဖော်ပြသဖြင့် နိုင်ငံတော်၏ လူမှုရေးနှင့်စီးပွားရေး အကျိုးတို့ကို အထောက်အပြုပါသည်။ တိုက်ရိုက် အကျိုးပြုခြင်း၊

- သုတေသနလုပ်ဆောင်ရန်အတွက် Problem ဖော်ထုတ်ခြင်းတွင် အားကောင်းသည်။ အင်ဂျင်နီယာ ဘူမိဗေဒကို အခြေခံ၍ လုပ်ဆောင် ရန်အတွက် Literature Survey ပြည့်စုံသည်။ ကွင်းမဆင်းမီ Desk Study လုပ်ဆောင်ပြီးနောက် Flied study များကို Sequence ထိမိစွာလုပ်ဆောင်ခြင်း၊ Laboratory တွင်စမ်းသပ်ခြင်း၊ ဆန်းစစ်ခြင်း၊ ဆက်စပ်အဖြေထုတ်ခြင်းတို့တွင် အားကောင်းသည်။ ပါရဂူကျမ်းပါ သုတေသန တွေ့ရှိချက်သည် သဘာဝဘေးအန္တရာယ် ကာကွယ်ရေးတွင် အထူး အရေးပါခြင်း၊

တို့ကြောင့် **သိပ္ပံပညာရပ်ဆိုင်ရာ** မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆု အတွက် ရွေးချယ်ခဲ့ခြင်း ဖြစ်ပါသည်။

(၈-၅)သိပ္ပံ ပညာရပ်(၂) - **အဏ္ဏဝါသိပ္ပံ ဘာသာရပ်**
ဒေါက်တာ ဝင်းဝင်းနွယ်
ကထိက၊ အဏ္ဏဝါသိပ္ပံဌာန၊
စစ်တွေတက္ကသိုလ်

ကျမ်းခေါင်းစဉ် - **Biology and Culture of Green Mussel *Perna Viridis* (Linnaeus, 1758) from Ye Estuary in Mon State**

(က) သိပ္ပံပညာရပ်တွင် ပညာရှင်အဖွဲ့ဆုရသူ လေးဦးအနက် ဒေါက်တာ ဝင်းဝင်းနွယ် သည် ၂၀၁၉ ခုနှစ်တွင် မော်လမြိုင်တက္ကသိုလ်မှ အဏ္ဏဝါသိပ္ပံဘာသာရပ်ဖြင့် ပါရဂူဘွဲ့ ရရှိခဲ့သူ ဖြစ်ပါသည်။

(ခ) ဒေါက်တာ ဝင်းဝင်းနွယ် ၏ သုတေသနသည် –

- အသုံးချသုတေသန နှင့် Production oriented သုတေသန ကိုယ်ပိုင်သုတေသန မြန်မာနိုင်ငံတွင် ပထမဦးဆုံးသော Mussel hatchery culture ဖြစ်ခြင်း၊
- Mussel biology အပိုင်း နှင့် culture အပိုင်းတွင် ပါဝင်သင့်သည့် aspects နှင့် လေ့လာရမည့် parameters အပြည့်အစုံပါဝင်သည်။ Marine Science/ Marine Biology ဘာသာရပ်အတွက် အလွန်အထောက်အကူ ပြုခြင်း၊
- ပါရဂူကျမ်းပါသုတေသနတွေ့ရှိချက်သည် Mussel စီးပွားဖြစ် မွေးမြူရေး အခြေခံ Mussel pilot scale production ကို အထောက်အကူပြုခြင်း၊

တို့ကြောင့် **သိပ္ပံပညာရပ်ဆိုင်ရာ** မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆု အတွက် ရွေးချယ်ခဲ့ခြင်း ဖြစ်ပါသည်။

(စ-ဖ)သိပ္ပံ ပညာရပ်(၃) - **ကုန်ထုတ်ဓာတုဗေဒ ဘာသာရပ်**
ဒေါက်တာ ဇာဇာဦး
လက်ထောက်ကထိက၊ ကုန်ထုတ်ဓာတုဗေဒဌာန
ရတနာပုံတက္ကသိုလ်

ကျမ်းခေါင်းစဉ် - **Isolation of Protein from Different Indigenous Beans and Its Utilization in Food Industries**

(က) **သိပ္ပံပညာရပ်**တွင် ပညာရှင်အဖွဲ့ဆုရသူ လေးဦးအနက် **ဒေါက်တာ ဇာဇာဦး** သည် ၂၀၁၉ ခုနှစ်တွင် ရန်ကုန်တက္ကသိုလ်မှ **ကုန်ထုတ်ဓာတုဗေဒဘာသာရပ်** ဖြင့် ပါရဂူဘွဲ့ ရရှိ ခဲ့သူ ဖြစ်ပါသည်။

(ခ) ဒေါက်တာ ဇာဇာဦး ၏ သုတေသနသည် –

- မြန်မာနိုင်ငံတွင် အမြောက်အများစိုက်ပျိုးထုတ်လုပ်သော မတ်ပဲ၊ ကုလားပဲနှင့် ပဲရာဇာတို့မှ တန်ဖိုးမြှင့်ထုတ်ကုန်ပရိုတင်းကို ထုတ်လုပ်သည့် သုတေသနဖြစ်သည်။ ပရိုတင်းကို edible film အဖြစ် သုံးစွဲနိုင်ရန်လည်းကောင်း သက်သတ်လွတ် စားသုံးသူများအတွက် လည်းကောင်း၊ ပရိုတင်းဓာတ်ချို့တဲ့သူများအတွက် လည်းကောင်း၊ ယခင်က ပြုလုပ်ခဲ့ခြင်း မရှိခဲ့သေးသော သုတေသန ဖြစ်ခြင်း၊
- ပဲကုန်ကြမ်းများမှ ဆီ၊ အမျှင်နှင့် ကစီဓာတ်များကိုဖယ်ရှားရာတွင် အမြင့်ဆုံး အကောင်းဆုံး ဖယ်ထုတ်နိုင်သည့် Ethanol soaking နှင့် Soxhlet extractor နည်းလမ်းကိုတင်ပြခြင်း၊ အယ်ကာလီတွင် စိမ်၍ အက်ဆစ်တွင် အနည်ချသော နည်းလမ်း (Isoelectric Precipitation) ဖြင့် အမျှင်နှင့်ကစီဓာတ်များကို အများဆုံး ဖယ်ထုတ်နိုင်သည့်နည်းကို သိပ္ပံနည်းကျတင်ပြ ထားသည်ကို တွေ့ရှိရခြင်း၊
- ပဲကုန်ကြမ်း(၃) မျိုးမှ ခွဲထုတ်ရရှိသည့် ပရိုတင်းများ၏ ဂုဏ်သတ္တိများကိုလည်း စနစ်အကျ ဖော်ထုတ်တင်ပြခြင်း၊ မတ်ပဲမှပရိုတင်းရာခိုင်နှုန်း အများဆုံးရရှိကြောင်း၊ ရရှိလာသည့် ပရိုတင်းများကို Protein Tablet ၊ Protein Based Edible Film အဖြစ် လည်းကောင်း၊ ကြက်/ဝက်အူချောင်းတွင် Meat Extender အနေဖြင့်လည်းကောင်း၊ ထပ်မံတန်ဖိုးမြင့်ပေးနိုင် ကြောင်း၊ ၎င်းထုတ်ကုန်များတွင် ရှိရမည့် အရည်အသွေးများ၊ ကြံ့ခိုင်မှုနှင့် သက်တမ်းများကိုလည်း လည်းကောင်း၊ တန်ဖိုးမြင့်ပရိုတင်း ထုတ်ကုန်အဖြစ်သို့ ပြောင်းလဲပေးနိုင်သည့် သုတေသနလုပ်ငန်း အဆင့်ဆင့်ကိုလည်းကောင်း၊ တင်ပြထားသဖြင့် နိုင်ငံတော်၏ စီးပွားကဏ္ဍကို တိုက်ရိုက် အကျိုးပြုနိုင်သော သုတေသနဖြစ်ခြင်း၊

တို့ကြောင့် **သိပ္ပံပညာရပ်ဆိုင်ရာ** မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆုအတွက် ရွေးချယ်ခဲ့ခြင်း ဖြစ်ပါသည်။

(၈-၇)သိပ္ပံ ပညာရပ်(၄) - **ရူပဗေဒ ဘာသာရပ်**

ဒေါက်တာဇေယျာပြည့်ဖြိုးအောင်
သရုပ်ပြ၊ ရူပဗေဒဌာန၊
ရန်ကုန်တက္ကသိုလ်

ကျမ်းခေါင်းစဉ် - **Preparation and Characterization of SnO_2 Nanofiber and Thin Film Photoelectrodes for Dye Sensitized Solar Cells**

(က) သိပ္ပံပညာရပ်တွင် ပညာရှင်အဖွဲ့ဆုရသူ လေးဦး အနက် **ဒေါက်တာ ဇေယျာပြည့်ဖြိုးအောင်** သည် ၂၀၁၉ ခုနှစ်တွင် ရန်ကုန်တက္ကသိုလ်မှ **ရူပဗေဒ ဘာသာရပ်** ဖြင့် ပါရဂူဘွဲ့ ရရှိခဲ့သူဖြစ် ပါသည်။

(ခ) ဒေါက်တာ ဇေယျာပြည့်ဖြိုးအောင်၏ သုတေသနသည် –

- Nanoscale ရှိသော Fibre Homemade ပစ္စည်းကို Electro spinning setup ဖြင့် ပြုလုပ်နိုင်ပြီး Solar Cell တည်ဆောက်ထားသဖြင့် Local Need အတွက် အသုံးဝင်သော ပင်ကိုယ် သုတေသနဖြစ်သည်။ Homemade ဖြင့်ပြုလုပ်သော်လည်း Nanoscale fibre များ ရရှိသည့်အပြင် Solar cell ရရှိသည်အထိ ပြုလုပ်နိုင်ကြောင်း တွေ့ရှိရခြင်း၊
- Thin Film Design နှင့် Nano Fibre Design ကို နှိုင်းယှဉ်ထားသည်ကိုလည်း တွေ့ရှိရပါသည်။ လက်တွေ့နယ်ပယ်အထိ အထောက်အကူပြုသော သုတေသန ဖြစ်ခြင်း၊
- ရူပဗေဒဘာသာရပ်၏ Photo voltaic Device Fabrication နှင့် Optoelectronic နယ်ပယ်ခွဲများအပြင် Materials Science and Engineering ဘာသာရပ် အတွက် တိုက်ရိုက် အကျိုးပြုသော သုတေသနတစ်ခုဖြစ်ခြင်း၊

တို့ကြောင့် **သိပ္ပံပညာရပ်ဆိုင်ရာ** မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆုအတွက် ရွေးချယ်ခဲ့ခြင်း ဖြစ်ပါသည်။

(၈-၈) လူမှုရေး ပညာရပ်(၁) - **စီးပွားရေးပညာ ဘာသာရပ်**
ဒေါက်တာ လှိုင်လှိုင်မိုး
တွဲဖက်ပါမောက္ခ၊ စာရင်းအင်းပညာဌာန
ရန်ကုန်စီးပွားရေးတက္ကသိုလ်

ကျမ်းခေါင်းစဉ် - **Modelling Residents' Support for Tourism Development with Special Reference to Bagan-Nyaung Oo Area, Myanmar**

(က) **လူမှုရေးပညာရပ်**တွင် ပညာရှင်အဖွဲ့ဆုရသူ သုံးဦးအနက် **ဒေါက်တာလှိုင်လှိုင်မိုး** သည် ၂၀၁၉ ခုနှစ်တွင် ရန်ကုန်စီးပွားရေးတက္ကသိုလ်မှ **စာရင်းအင်းပညာဘာသာရပ်** ဖြင့် ပါရဂူဘွဲ့ ရရှိခဲ့သူဖြစ်ပါသည်။

(ခ) ဒေါက်တာ လှိုင်လှိုင်မိုး၏ သုတေသနသည် –

- နိုင်ငံတော်၏ လူမှုရေးနှင့်စီးပွားရေးဖွံ့ဖြိုးတိုးတက်မှုအတွက် အထောက်အကူ ပြုနိုင်ခြင်း၊ အထူးသဖြင့် နိုင်ငံတော်အတွက် အထူးအရေးကြီးလှသည့် ခရီးသွား လုပ်ငန်း ဖွံ့ဖြိုးတိုးတက်ရေးနှင့် ဒေသခံပြည်သူများ၏ စီးပွားရေးနှင့် လူမှုရေးဖွံ့ဖြိုး တိုးတက်ရေးအတွက် ခရီးသွားလုပ်ငန်းကဏ္ဍ၏ အရေးပါမှုကို ဖော်ထုတ်တင်ပြ ထားသည့် သုတေသနကောင်း တစ်ခုဖြစ်ခြင်း၊ ဤပါရဂူကျမ်းစာသည် ပင်ကိုယ် ရေးသုတေသန ကျမ်းစာဖြစ်ပြီးကျမ်းပြုသူ၏ ကိုယ်တိုင် အသစ်လုပ်ဆောင်ချက်၊ တွေ့ရှိချက်များကိုတင်ပြထားခြင်း၊
- ဤပါရဂူကျမ်းစာသည့် Problem ဖော်ထုတ်ခြင်း၊ Literature Survey ပြုလုပ်ခြင်း၊ သုတေသန လုပ်ငန်းပိုင်းဆိုင်ရာဖြစ်သည့် အချက်အလက်များ ရှာဖွေကောက်ယူ ရာတွင် ပုဂံ-ညောင်ဦးဒေသရှိ ဒေသခံပြည်သူများအားနမူနာ စစ်တမ်းကောက်ယူ ၍ အချက်အလက်များရှာဖွေစုဆောင်ထားခြင်း၊ တိုင်းတာခြင်း၊ ဆန်းစစ်ခြင်းနှင့် အဖြေထုတ်ခြင်းတို့အတွက် စာရင်းအင်းဆိုင်ရာနည်းလမ်းဖြစ်သော SEM model ကိုစနစ်တကျ တည်ဆောက်၍ လုပ်ဆောင်ထားခြင်း၊ ခြုံငုံဆက်စပ်သုံးသပ်ခြင်းနှင့် နိဂုံး၊ ကျမ်းကိုးစာရင်းစသည်တို့ကို စနစ်တကျ ပြည့်စုံမှန်ကန်စွာတင်ပြထားသော ပါရဂူကျမ်းစာ တစ်ခုဖြစ်ခြင်း၊
- ဤပါရဂူသုတေသန၏တွေ့ရှိချက်၊ တင်ပြချက်များသည် New Knowledge, Insight, Information, approach, design, result and Policy recommendation များကို ပေးစွမ်းနိုင်သော ကျမ်းစာ တစ်ခုဖြစ်ခြင်း၊
- သုတေသန ကျမ်းစာနှင့် အစီရင်ခံစာတို့သည် Format (ပုံစံ) ကျနမှု နှင့် Style ဟန်တွင် တင်ပြဟန်၊ အထားအသို၊ အပြင်အဆင်၊ အခန်းဖွဲ့ခြင်းတို့တွင် စလယ် ဆုံး ကောင်းမွန်မှုရှိခြင်း၊

တို့ကြောင့် **လူမှုရေးပညာရပ်ဆိုင်ရာ** မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆုအတွက် ရွေးချယ်ခဲ့ခြင်း ဖြစ်ပါသည်။

(၈-၉)လူမှုရေး ပညာရပ်(၂) - **ပညာရေးသဘောတရား ဘာသာရပ်**

ဒေါက်တာ ခိုင်ရည်မွန်

ကထိက၊ ပညာရေးသဘောတရားဌာန

ရန်ကုန်ပညာရေးတက္ကသိုလ်

ကျမ်းခေါင်းစဉ် - **An Analytical Study of Parenting Knowledge and Practices**

(က) **လူမှုရေးပညာရပ်** တွင် ပညာရှင်အဖွဲ့ဆုရသူ သုံးဦးအနက် **ဒေါက်တာ ခိုင်ရည်မွန်**သည် ၂၀၁၉ ခုနှစ်တွင် ရန်ကုန်ပညာရေး တက္ကသိုလ်မှ **ပညာရေးသဘောတရားဘာသာရပ်** ဖြင့် ပါရဂူဘွဲ့ရရှိခဲ့သူ ဖြစ်ပါသည်။

(ခ) ဒေါက်တာ ခိုင်ရည်မွန်၏ သုတေသနသည် –

- ဤသုတေသနသည် နိုင်ငံ၏ဘက်စုံဖွံ့ဖြိုးမှုအတွက် လူသားအရင်းအမြစ် ဖြစ်လာမည့် ကလေးသူငယ်များ၏ ရုပ်ပိုင်း၊ စိတ်ပိုင်းပေါင်းသင်းဆက်ဆံရေး ဥာဏ်ရည်ပိုင်းလုပ်ဆောင်ချက်များကို သိရှိရန် အကျိုးပြုခြင်း။
- ဤသုတေသနသည် ရှေးဦးကလေးသူငယ်အရွယ်ဖြစ်သော အသက် ၈ နှစ်အောက် ကလေးများ၏ ရုပ်ပိုင်း၊ စိတ်ပိုင်း၊ ပေါင်းသင်းဆက်ဆံရေးပိုင်းနှင့် သိမှုဥာဏ် ရည်ပိုင်း ဆိုင်ရာ ဖွံ့ဖြိုးတိုးတက်မှုအတွက် မိဘများ၏ ပြုစုပျိုးထောင်မှုပုံစံလုပ်ဆောင်ချက် များကို လေ့လာရှာဖွေဆန်းစစ်ထားခြင်း။
- ဤသုတေသနရှိဖေါ်ပြချက်၊ တွေ့ရှိချက်၊ အကြံပြုချက်များကို လေ့လာကျင့်သုံးခြင်းအားဖြင့် မိဘများသည် အရေးကြီးလှသော မိဘအခန်းကဏ္ဍာကို သိရှိလာပြီး ၎င်းတို့၏ သားသမီးများအား မှန်ကန်ကောင်းမွန်ပြည့်စုံသော နည်းလမ်းများဖြင့် ပြုစုပျိုးထောင်နိုင်စေရန် အသိပညာ ပေးနိုင်ပြီးပြည့်စုံ ကောင်းမွန်သော Parenting education program and policies ရေးဆွဲရာတွင်လည်း လိုအပ်ချက်များကို ထည့်သွင်း စဉ်းစားနိုင်လာမည်ဖြစ်ခြင်း၊
- ဤသုတေသနသည် မည်သူမျှ လုပ်ဆောင်ခြင်းတွေ့ရှိခြင်း၊ တင်ပြခြင်း၊ ယူဆခြင်းတို့ မရှိဖူးသေးသော သုတေသနကျမ်းဖြစ်ပြီး ဤသုတေသနကျမ်းရှိ လုပ်ဆောင်ချက်၊ တွေ့ရှိချက်နှင့် တင်ပြချက်များသည် ပင်ကိုယ် သုတေသန ဖြစ်ပြီး၊ Early Childhood Education နှင့် ပါတ်သက်လျှင် ဤသုတေသန ကျမ်းကို ကိုးကား အသုံးပြုနိုင်ခြင်း၊ ကိုယ်တိုင်ချဉ်းကပ် လုပ်ဆောင်ရာတွင် စနစ်ကျခြင်း၊ သိပ္ပံနည်းကျစွာ လုပ်ဆောင် ထားခြင်း၊
- Problem ဖေါ်ထုတ်ခြင်း အပိုင်းသည် ကလေးသူငယ် ပြုစုပျိုးထောင်ခြင်းအတွက် လိုအပ်ချက်ကို ပေါ်လွင်စေပါသည်။ Literature Survey လုပ်ရာတွင်လည်း မှန်ကန်မှု ပြည့်စုံမှုရှိသည်ကို တွေ့ရှိရပါသည်။ အချက်အလက်ရှာဖွေခြင်း၊

တိုင်းတာ စစ်ဆေးခြင်း၊ အဖြေထုတ်ခြင်းတို့သည် မှန်ကန်မှု၊ ခိုင်မာမှုနှင့် ယုံကြည်နိုင်မှု ရှိကြောင်းတွေ့ ရှိရပါသည်။ နိဂုံးတွင် ခြုံငုံဆက်စပ်သုံးသပ်ခြင်း၌ မှန်ကန်မှု၊ ခိုင်လုံမှု၊ လက်ခံနိုင်မှုနှင့် ပြည့်စုံမှုတို့ရှိခြင်း၊ ကျမ်းကိုး စာရင်းရေးသားရာတွင် မှန်ကန်မှု ရှိခြင်း၊

- ဤသုတေသနကျမ်းသည် Community Leadership အဖြစ်မိမိရပ်ရွာတွင် ပါဝင်အကျိုးပြုနိုင်အောင် ပညာရေးသဘောတရား ဘာသာရပ်မှတဆင့် ရှင်းလင်းအသိပေး အကျိုးပြုနိုင်ခြင်း။ ကျမ်းရေးနည်းပုံစံအရ ပြည့်စုံကာ၊ စနစ်တကျ ဖော်ပြထားပြီး အင်္ဂလိပ်စာ အရေးအသားမှန်ကန်ကောင်းမွန်၍ ရှင်းလင်းသေသပ်မှု ရှိခြင်း။ အောက်ပါ ကြောင်းအရာများ ပါဝင်ကာ ပြည့်စုံစနစ်ကျခြင်း၊
- Title, Approval Sheet, Acknowledgement, Abstract, Table of Content, Text(Body), Introductory Chapter, Literature Review, Report of study, Research Methodology, Recommendation ပြည့်စုံခြင်း၊

တို့ကြောင့် **လူမှုရေးပညာရပ်ဆိုင်ရာ** မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆု အတွက် ရွေးချယ်ခဲ့ခြင်း ဖြစ်ပါသည်။

(၈-၁၀) လူမှုရေး ပညာရပ်(၃) - **ဥပဒေပညာ ဘာသာရပ်**
ဒေါက်တာ ဖြူဖြူသင်း
ကထိက၊ ဥပဒေပညာဌာန
ရန်ကုန်တက္ကသိုလ်

ကျမ်းခေါင်းစဉ် - **Legal Study on the Interpretation and Implementation of TRIPS Agreement**

(က) **လူမှုရေးပညာရပ်**တွင် ပညာရှင်အဖွဲ့ဆုရသူ သုံးဦးအနက် **ဒေါက်တာ ဖြူဖြူသင်း** သည် ၂၀၁၉ ခုနှစ်တွင် ရန်ကုန်တက္ကသိုလ်မှ **ဥပဒေပညာဘာသာရပ်** ဖြင့် ပါရဂူဘွဲ့ရရှိခဲ့သူ ဖြစ်ပါသည်။

(ခ) ဒေါက်တာ ဖြူဖြူသင်း၏ သုတေသနသည် –

- စာတမ်းသည် ပြည်ထောင်စုသမ္မတမြန်မာနိုင်ငံတော် စျေးကွက်စီးပွားရေးစနစ်နှင့် အညီ မြန်မာ ပြည်သူများ၏ မူပိုင်ခွင့်ကို ရရှိစေရန် အပြည်ပြည်ဆိုင်ရာ ဥပဒေနှင့် အညီ လေ့လာသုံးသပ်ချက်များပါဝင်၍ နိုင်ငံတော်စီးပွားရေး၊ လူမှုစီးပွားရေးကို အထောက်အကူပြုခြင်း၊ ကျမ်းစာတွင်ပါဝင်သော လေ့လာသုံးသပ်ချက်များသည် ပင်ကိုယ် လေ့လာသုံးသပ်ချက်များဖြစ်ခြင်း၊

- Legal research method ကို စနစ်တကျကျင့်သုံးပြီး Literature review နှင့် Social needs ကို အပြည်ပြည်ဆိုင်ရာ ဥပဒေနှင့်ယှဉ်တွဲပြီးသုံးသပ်တင်ပြထားခြင်း၊ ဥပဒေပညာ ဘွဲ့ကြို ၊ ဘွဲ့လွန်သင်တန်းများတွင် ခေတ်နှင့် အညီ Intellectual Property Rights ကို ဘာသာရပ် တစ်ခုအဖြစ်ထည့်သွင်း သင်ကြားလျက်ရှိရာ သင်ကြားရေးများတွင် များစွာ အထောက်အကူ ပြုနိုင်ခြင်း၊
- ပါရဂူဘွဲ့ကျမ်းတစ်စောင်တွင် ပါဝင်သင့်သော Introduction Chapters, Text (Body), Results, Discussion, Conclusion နှင့် References တို့ကို စနစ်ကျနစွာ တင်ပြထာခြင်း

တို့ကြောင့် **လူမှုရေးပညာရပ်ဆိုင်ရာ** မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆု အတွက် ရွေးချယ်ခဲ့ခြင်း ဖြစ်ပါသည်။

FACEBOOK USE, ATTITUDE TOWARD FACEBOOK, SELF-ESTEEM AND COLLEGE ADJUSTMENT AMONG MONYWA UNIVERSITY STUDENTS

FACEBOOK USE, ATTITUDE TOWARD FACEBOOK, SELF ESTEEM AND COLLEGE ADJUSTMENT AMONG MONYWA UNIVERSITY STUDENTS

Khin Nwe Sint[1]

Abstract

This study explores the effect of Facebook intensity on self-esteem and student's adaptation to college among Monywa University students in Myanmar. The present study constructed the scales designed to measure Facebook intensity, self-esteem, and student's adaptation to college applicable to Myanmar socio-cultural context. In this study, Facebook intensity was measured by the following factors: Facebook use (the number of Facebook Friends and Time spent on Facebook) and Attitude towards Facebook Emotional connection to Facebook and Social connection to Facebook). The student's adaptation to college was assessed by using four subscales: Personal-emotional adjustment scale, Social adjustment scale, Academic adjustment scale, and Attachment to institution scale. The self-esteem of the participants was measured by using Rosenberg Self-esteem Scale Myanmar Version. Then, a questionnaire survey was carried out with 400 participants (200 first year students and 200 third year students) from Monywa University in Myanmar. As a result, in Pearson correlation, it was found that there, correlation between self-esteem and Facebook intensity. In addition, it was also found that the higher the Facebook Intensity, the lower the Personal-emotional adjustment but the higher Social adjustment. Each multiple regression was run to predict each dependent variable from each of the independent variables. These variables statistically predicted for Personal-emotional adjustment (F (5, 394) 14.00, p<.001, R2 = .15), Social adjustment (F (5, 394) = 17.87, p<.001, R2 = .19), Academic adjustment (F (5, 394) = 22.51, p<.001, R2 .22) and Attachment to institution (F (5, 394) = 10.26, P<. OOI, R2 = .12). Furthermore, on analysis of variance was used to explore whether fresher and senior student were different in Facebook us and their attitudes towards Facebook. The results showed that the two groups has significant differences in the number of Facebook friends but not significant in time spent on Facebook. It was also found that the two groups had significant differences in emotional connection to Facebook and social connection to Facebook. The result suggested that fresher students had stronger emotional connection to Facebook and social connection to Facebook than senior students.

Keywords; Facebook intensity, Attitude toward Facebook, Self-esteem and Personal-emotional adjustment

Introduction

Facebook began a year later as a Harvard only SNS launched in 2004 by former Harvard student Mark Zuckerberg. The creation of Facebook has revolutionized social behaviors and networking practices among college students. Facebook allows a user to create a profile, display personal information, upload pictures, access other user's profiles, accumulate online friends and interact with those friends through messages, gifts and other application. Past research has extensively examined the effects of general internet use on social wellbeing. More recently, there has been an increasing interest in studying the use and effects of Facebook (Kalpidou, Costin, & Morris, 2011). In recent years, online social-networking sites have achieved notable popularity among college students. Although Facebook has its advantages, it decreases opportunities for face-to-face interactions with people (Sheldon, Abad & Flinch, 2011). Indeed, obsessive use of social media may lower educational achievement, increase procrastination, and contribute to missed social opportunities (Kirshner & Karpinski, 2010). For some, using social media can be an escape from life (i.e. social contacts) which may further isolate them and cause loneliness to occur (Huan,

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Ang & Chye, 2014). According to Leung, (2002), there is a relationship in the usage of social media and loneliness. Lonely individuals who reported using social media as a medium to aid in social isolation often found that online networking exacerbated their social isolation (Kim, LaRose, & Peng, 2009). It is necessary that human beings communicate with others because too much isolation may cause long-term effects, such as communication barriers, depression, anxiety and social awkwardness (Wang, 2013).

In the literature, the average amount of time spent on Facebook range from 30 minutes to over 2 hours daily. Ellison et al. found that Facebook use was related to bridging, bounding and maintaining social capital, which refers to resources obtained through relationships such as emotional satisfaction and access to information. On average, college students had between 150 and 200 Facebook friends and generally used the Web site to communicate with others whom they shared an offline connection. This indicated that students primarily used Facebook to maintain previously established social capital, rather than developing new networks through online networking. Most users named their high school in their profile and preserved ties with old friends and acquaintances, even as they moved into a new social setting.

Other studies have supported that Facebook is used primarily for social connections. Sheldon reported that students used Facebook to maintain relationships with people they already knew. Only a small number of students used Facebook to meet new people. Pempek et al., (2009) confirmed the above findings and added that college students also used Facebook to communicate information about their identity such as their political and religious beliefs. Facebook has also been viewed as the "social glue" tat assists students to become accustomed to college life. Stein field et al., (2008) found out that the intensity of Facebook use among college students predicted social capital a year later. Other research also shows that the ability to use Facebook to build social connections is influenced by personality traits. Sheldon found that socially anxious individuals tended to pass more time on Facebook friends but reported fewer Facebook friends. In contrast, extraverted individuals had more Facebook friends and initiated more relationships online than introverted participants did. Orr et al., (2009), examined the effects of shyness on Facebook use among college students and confirmed Sheldon's findings. Shy individuals spent more time on Facebook and expressed favorable attitudes toward Facebook but had few Facebook friends.

Ellison et al. found the students with low self-esteem and low life satisfaction benefited from Facebook use as it allowed them to improve their social capital. Valkenburget et al., (2007) proposed that positive feedback correlated positively with self-esteem and negative feedback was associated with lower self-esteem. Stinfield et al., (2008) has also been found that those who have lower self-esteem have more use of Facebook than those who have higher self-esteem. Altogether the findings suggest that Facebook users may fulfill their social needs, but it is not clear whether they can fulfill their emotional needs. It is possible that while Facebook stimulates social interaction; it also displaces time from establishing emotionally gratifying relationships.

Moreover, college adjustment is known fact that getting a college degree increases one's chance of having a better life. College and Universities play a big role. The transition from high school to college is challenging life transition in the development of young adults, and many students are inadequately prepared for the psychological, emotional, and academic realities of higher education Francis. The college freshman is confronted with the adaptation challenges of living apart from family and friends, adjusting to the academic regimen, assuming responsibility for the tasks of daily living, and developing a new array of social relationships with peers and faculty (Henton, Lamke, Murphy, & Haynes, 1980). College adjustment refers to how well students think they fulfill various academic and social demands associated with university

experience (Akba11k,1998). And also adjusting to college life requires the overcoming of several concerns includes: academic adjustment, social adjustment, personal-emotional adjustment and attachment to the institution.

In Myanmar, the number of Facebook users had significantly increased from 1,060,000 in 2013 to 7,100,000 in 2015 (Internet World Stats). However, there has been little research on how much, why and how students use online social networking sites, especially Facebook and on its relationship with psychological well-being in Myanmar. Therefore, a survey study was conducted on Facebook use of students from Monywa University in Myanmar as the initial stage. The survey results show that the majority of the participants use Facebook several times within a day and the amount of time spend 3 hours on Facebook per day and the number of Facebook friends are between 100 and 700. According to this result, it can be generally said that Facebook is the preferred approach to networking among Monywa University students.

For this reason, this study focused on undergraduate University students because undergraduate students have a lot of Facebook use in our country. The purpose of this study is to explore the effect of Facebook intensity on self-esteem and student's adaptation to college. Additionally, this research will explore whether these relationships differ among first year and senior students because first year students are in the process of developing a social network in their new environment, whereas senior students should have an established social network already (Kalpidou et al., 2011). Based on the empirical literature, the following research hypotheses were formulated:

Hypotheses 1: There is a negative relationship between Facebook intensity and self-esteem.

Hypotheses 2: There is a negative relationship between Facebook intensity and personal emotional adjustment to college.

Hypotheses 3: There is a positive relationship between Facebook intensity and social adjustment to college.

Hypotheses 4: There is a negative relationship between Facebook intensity and academic adjustment to college.

Hypotheses 5: Fresher and senior students are different in Facebook use and attitudes toward Facebook.

Method

This chapter presents how the researcher conducted a questionnaire study concerning about what participants were used, how the data were collected and what measures were used.

Participants

The participants consisted of 400 students who are first year students (N=200) and third year students (N=200) from Monywa University.

Procedure

Permission for the participants to take part voluntarily in the study during school time was obtained from the Rector of Monywa University. The students were informed that participating in this study was voluntary and the procedure of completing the test battery was explained. Consequently, they received a set of questionnaire to complete. It took about 35 minutes to answer

these questionnaires. After that, their responses of the each scale were scored to compute Descriptive statistics, Pearson correlation, regression analysis and One-way ANOVA.

Measures

Three types of scale:(Facebook Intensity Scale, Rosenberg Self-Esteem scale (1965) and Student Adjustment to College questionnaire (SACQ)) were used in this study.

Myanmar version of Facebook Intensity Scale. Myanmar version of Facebook Intensity Scale was used in the present study. It consisted of 12 items that measures Facebook use (time spent on Facebook, the number of Facebook friends), attitudes toward Facebook (emotional connection to Facebook, Social connection to Facebook). This measure of these factors are time spent on Facebook "0-2", 2= "3-4", 3= "5-6", 4= "7-8", 5= more than 9), and number of Facebook friend (1= "0-100", 2= "101-200", 3= "201-300", "301-400", 5=more than 400). Items were summed within scale: score could range from 1 to 5. More than 400 friends represent high the number of Facebook friend and more than 9 hours represents a lot of Facebook use. Each statement of emotional connection to Facebook and social connection to Facebook is evaluated on a 5- point scale ranging from "1= strongly disagree to 5= strongly agree". Items were summed within scale: score could range from 1 to 5 with higher score indicating higher emotional and social connection to Facebook. The value of reliability coefficient is .74 for emotional connection to Facebook and .63 for social connection to Facebook. Moreover, a measure is "how many friends the participants had offline and specifically on campus". Items were summed within scale: score could range from 1 to 5.1tems were summed within scale: score could range from 1 to 5. More than 400 friends represent high, the number of Facebook friend.

Myanmar version of Rosenberg Self-Esteem Scale. Myanmar version of Rosenberg Self-Esteem Scale was used in this study. It consists of 9 items. Each statement evaluated on a 4-point Likert scale ranging from strongly Disagree to strongly agree. Item numbers (2, 5, 6, and 8) are reverse items. Items were summed within scale: score could range from 9 to 36 with higher score indicating higher self-esteem. The value of reliability coefficient is .69.

Myanmar version of Student Adjustment to College Questionnaire (SACQ). Myanmar version of Student Adjustment to College Questionnaire was used in the present study. The total items of this Scale included 65 items. It has four factors composites that are academic adjustment, personal-emotional adjustment, institutional attachment and social adjustment. Each statement is evaluated on a Likert 5-point scale. Items were summed within scale: score could range from 1 to 5 with higher score indicating higher adjustment. The value of reliability coefficient is .88 for Student Adaptation to College Questionnaire (total), .76 for personal emotional adjustment, .76 for social adjustment, .82 for academic adjustment and .76 for institutional attachment.

Results

Table 1 Descriptive statistics of Facebook intensity, Self-esteem, and Student's Adaptation to college

Variables	Description	FY 0=200)			
		Mean	SD	Mean	SD
Onfriends	1=1-100, 2=101-200,3=201-300 4=301-400, 5= more than 400	2.87	1.70	3.31	1.57
Hours	1=0-1, 2=3-4, 3=5-6, 4=7-8, 5=more than 9	2.02	1.29	1.91	1.11
Emoconnet	Aggregation of responses to 6 questions	18.54	4.33	17.04	3.92
Soconnet	Aggregation of responses to 4 questions	14.00	2.90	13.21	2.67
Offfriends	1=1-100, 2=101-200, 3=201-300, 4=301-40=0, 5= more than 400	1.39	.99	1.48	.92
Sefestem	Aggregation of responses to 9 questions	24.58	3.41	24.71	3.10
Pemoadj	Aggregation of responses to 15 questions	42.76	8.77	43.88	8.16
Socadj	Aggregation of responses to 18 questions	63.70	7.38	62.66	7.62
Acaadj	Aggregation of responses to 24 questions	85.12	11.78	80.34	11.40
Attinsti	Aggregation of responses to 7 questions	29.71	3.93	28.58	4.20
Sacq	Aggregation of responses to 65 questions	224.87	23.62	219-26	22.40

Notes: Onfriends = Number of Facebook friends, HoursTime spend on Facebook,

Emoconnet=Emotional Connection to Facebook, Soconnet=Social Connection to Facebook, Offiiend = Campus friends, Sefestem self-esteem, Pemoadj=Personal emotional adjustment, Socadj =Social adjustment, Acaadj = Academic adjustment, Attinsti=institutional attachment, Sacq College adjustment, FY=First year students, SS Senior students

As shown in Table l, mean number of emotional connection to Facebook (FY:18.54, SS:17.04), social connection to Facebook (FY:14.OO, SS:1321), number of Facebook friends (FY:2.87, SS:3.31), time spent on Facebook (FY: 2.02, SS:1.91), Offline friends (FY: 1.39, SS: 1.48), self-esteem (FY:24.58, SS:24.71), Academic adjustment (FY:85.12, SS;80.34), emotional adjustment (FY:42.76, SS:43.88), institutional attachment (FY:29.71, SS:28.58), social adjustment (FY:63.70, SS:62.66) and total adjustment (FY :224.87, SS:219.26).

Correlations among Facebook intensity, Self-esteem and Student's Adaptation to College (N=400)

As shown in Table 1, correlation analysis indicated that Facebook intensity was not related to self-esteem. There was negative correlation between Facebook intensity and personal emotional adjustment -.20, ($p<0.01$). It was also found that there was positive correlation between Facebook intensity and social adjustment. 20, ($p<0.01$). However, Facebook intensity was no correlation between academic adjustment and attachment to institution. Because, the study was specifically interested in finding for Facebook friend, time spent, emotional connection and social connection, this study treated these variables separately.

The correlation analysis revealed that there was significant positive relationship between emotional connection to Facebook and self-esteem (r .10, $p<0.05$ level). The results of this study also found that there was positive correlation between self-esteem and personal emotional

adjustment (r=.31, p<0.01), and social adjustment (r=.34, p<0.01), and academic adjustment (r=.42, p<0.01), and attachment to institution (.30, p<O.01).

This study also indicated that there were significant negative correlation between the number of Facebook friends and personal emotional adjustment (r = -.10, p< 0.05) and academic adjustment (r= -.19, p<0.01) and attachment to institution (r = -.13, p<O.001). But, the number of Facebook friends is not correlated with social adjustment. It was also found that there were also significant negative correlation between time spent on Facebook and personal emotional adjustment (r= -.17, p<0.01) and academic adjustment (r= 19, p<0.01) and attachment to institution (r= -.13, p<0.01). However, time spent on Facebook was not correlated with social adjustment.

Moreover, there was significant negative correlation between emotional connection to Facebook and personal emotional adjustment (r -.14, p<0.01). It was also found that there was significant positive correlation between emotional connection to Facebook and social adjustment (r .16, p < 0.01). But, there was no correlation between emotional connection to Facebook and academic adjustment and attachment to institution.

Table 2 Correlation between Facebook Intensity, Self-esteem and Adaptation to college (N=400)

Varibles	Onfriends	Hours	Emoconnet	Socconnet	Fbintens	Offfriends	Sfestem	Pemoadj	Socadj	Acadadj	Attinsti
Onfriends											
Hours	.32**										
Emoconnet	.24**	.28**									
Socconnet	.12*	.15**	.39**								
Fbintens	.49**	.48**	.86**	.69**							
Offfriends	.20**	.16**	..09	.11*	.17**						
Sfestem	-.01	-.03	.10*	.07	.09	.01					
Pemoadj	-.10*	-.17**	-.14	-.16**	-.20**	-.01	.31**				
Socadj	.00	-.02	.16**	.25**	.20**	.01	.34**	.19**			
Acadadj	-.19**	-.14**	.03	.08	-.02	-.04	.42**	.28**	.40**		
Attinsti	-.13**	-.10	.04	.08	.01	-.04	.30**	.21**	.39**	.46**	

*p<0.05, **p<0.01, ***p<0.001

Note: Onfriends=Number of Facebook friends, Hours = Time spend on Facebook, Emoconnet =Emotional connection to Facebook, Socconnet= Social connection to Facebook, Fbintens=Facebook Intensity, Offfriends = Campus friends, Sfestem= Self-esteem, Pemoadj=Personnl emotionl adjustment, Socadj =Social adjustment Acadadj= Academic adjustment, Attinsti= Attachment to institutional

Finally, there was significant negative correlation between social connection to Facebook and personal emotional adjustment (r= -.16, p<0.01). It was also found that there was significant positive correlation between social connection to Facebook and social adjustment (r =.25, p<0.01). But, there was no correlation between social connection to Facebook and academic adjustment and attachment to institution. Another variable, the number of offline friends was positively correlated with only in social adjustment to college (r =.10, p<0.05).

Regression Analysis for combination effects of Facebook intensity and Self-esteem on Student's Adaptation to College

A multiple regression was run to predict student's adaptation to college from self-esteem, hours, online friends, emotional connection to Facebook and social connection to Facebook. According to table 3, 4, 5 and 6, these variables statistically predicted personal emotional adjustment (F=14.00, p<.001, R^2=0.15) and social adjustment (F=17.87, p<.001, R^2=0.19) and academic adjustment (F=22.51, p<.001, R^2=0.22) and attachment to institution (F=10.26, p<.001,

R^2=0.0.12). According to the result of the regression, R^2=15 percent of the variance in personal emotional adjustment, R^2=19 percent of the variance in social adjustment, R^2=22 percent of the variance in academic adjustment and R^2=12 percent of the variance in attachment to institution are determined by self-esteem, hours, online friends, emotional connection to Facebook and social connection to Facebook in combination.

Table 3 Regression Analysis for effects on Personal emotional adjustment (N=400)

Predictive variables	Personal emotional adjustment			
	β	**F**	**R^2**	**P(value)**
Sfestem	.32***	14.00	0.15	.001
Onfriends	-.03 ns			
Hours	-.11*			
Emoconnet	-.09 ns			
Soconnet	-.12*			

*p<0.05, **p<0.01, ***p<0.001

Table 4 Regression Analysis for effects on Social adjustment (N=400)

Predictive variables	Academic adjustment			
	β	**F**	**R^2**	**P(value)**
Sfestem	.33***	17.87	0.19	.001
Onfriends	-.03 ns			
Hours	-.06 ns			
Emoconnet	.07 ns			
Soconnet	.22***			

*p<0.05, **p<0.01, ***p<0.001

Table 5 Regression Analysis for effects on Academic adjustment (N=400)

Predictive variables	Academic adjustment			
	β	**F**	**R2**	**P(value)**
Sfestem	.40***	22.51	0.22	.001
Onfriends	-.18***			
Hours	-.09 ns			
Emoconnet	.03 ns			
Soconnet	.08 ns			

*p<0.05, **p<0.01, ***p<0.001

Table 6 Regression Analysis for creation effects on Attachment to Institution (N=400)

Predictive variables	Attachment to Institution			
	β	F	R2	P(value)
Sfestem	.29***	10.26	0.12	.001
Onfriends	-.13*			
Hours	-.07 ns			
Emoconnet	.03 ns			
Soconnet	.08 ns			

*p<0.05, **p<0.01, ***p<0.001

The difference between fresher and senior students in Facebook use and Attitude toward Facebook (ANOVA)

As shown in Table 7, results indicated that the two groups were difference in the number of Facebook friends. The senior students reported having significantly more friends on Facebook, F (1,398) = 7.42, p < 0.05, than fresher students did, M_{FY} = 2.87, M_{SS} =3.31.

Table 7 Differences between fresher and senior students in the number of Facebook friends (ANOVA)

Facebook Friends	N	Mean	SD	F	P(Va1ue)
Fresher students	200	2.87	1.70	7.42	< 0.05
Senior students	200	3.31	1.57		

According to table 8, the two groups were not different in the time spent on Facebook, M_{FY} = 2.02, M_{SS} 1.91.

Table 8 Differences between Fresher and senior students in the time spent on Facebook (ANOVA)

Facebook Hours	N	Mean	SD	F	P (Value)
Fresher students	200	2.02	1.29	.84	Ns
Senior students	200	1.91	1.11		

In table 9, the two groups were different in emotional connection to Facebook. Fresher students reported a stronger emotional connection to Facebook F (1,398) — 13.37, p <0.01, than senior students did, M_{FY} = 18.55, M_{SS} = 17.04.

Table 9 Differences between fresher and senior students in the emotional connection to Facebook (ANOVA)

Emotional connection to Facebook	N	Mean	SD	F	P (Value)
Fresher students	200	18.55	4.33	13.37	<0.01
Senior students	200	17.04	3.92		

According to table 10, the two groups were also different in social connection to Facebook. Fresher students reported a stronger social connection to Facebook F (1, 3987.82, p< 0.05 than senior students did, M_{FY} = 14, M_{SS}= 13.22.

Table 10 Differences between fresher and senior students in the social connection to Facebook (ANOVA)

Social connection to Facebook	N	Mean	SD	F	P (Value)
Fresher students	200	14	2.91	7.82	< 0.05
Senior students	200	13.22	2.67		

According to table 11, the two groups were not different in the number of offline friends, M_{FY}= 1.39, M_{SS} = 1.48.

Table 11 Differences between Fresher and senior students in the number of offline friends (ANOVA)

Offline Friends	N	Mean	SD	F	P (Value)
Fresher students	200	1.39	.99	.89	NS
Senior students	200	1.48	.92		

Discussion

This study was to explore the effect of Facebook intensity on self-esteem and the student's adaptation to college. Facebook intensity includes Facebook use and attitude toward Facebook. Facebook use consists of the number of Facebook friends and time spent on Facebook. In other words, Facebook use is measured by the number of Facebook friends and time spent on Facebook. Attitude toward Facebook was assessed by emotional connection to Facebook and social connection to Facebook scales. Student's Adaptation to College Questionnaire consists of 4 subscales: Personal emotional adjustment, Social adjustment, Academic adjustment and Attachment to institution.

Firstly, this study examined the correlation among Facebook intensity (Facebook use, Attitude toward Facebook), self-esteem and student's adaptation to college (personal emotional adjustment, social adjustment, academic adjustment and attachment to institution) by correlational analysis. Moreover, because the study was specifically interested in finding for Facebook friends, time spent, emotional and social connection to Facebook, this study explored these variables separately.

This study tested the hypothesis one: (there will be a negative relationship between Facebook intensity and self-esteem). The result indicated that there was no correlation between Facebook intensity and self-esteem. Thus, hypothesis 1 was not supported. Mehdizageh (2010) indicated that people with low self-esteem will be more engage an online activity that may raise their self-esteem. However, not only those with that self-esteem can benefit from using Facebook but this also applies to those with high self-esteem. Wilson et al., (2010) found that no link between self-esteem and social network site use. With respect to self-esteem, the result is also mixed, especially considering the different type of self-esteem. The present study was not found the relationship between low self-esteem and the use of Facebook. Today, everyone is using the Facebook as a popular social network. They seem to be more use Facebook for conformity than low self-esteem. Thus, it can be proposed that most people seem to bemore use Facebook because of their popular social network, satisfying and relaxing.

In addition, result also indicated that there was positive correlation between self-esteem and student's adaptation to college. Thus, our result suggests that self-esteem is one significant factor for student's adaptation to college. This finding is consistent with previous study (Kalpidou et al., 2011).

Moreover, this study examined the hypothesis two: (there will be a negative relationship between Facebook intensity and personal emotional adjustment to college). The result of this study found that there was negative correlation between Facebook intensity and personal emotional adjustment to college (r= -.17**). Thus, hypothesis 2 was supported. Our result suggests that if the more use of Facebook intensity, the lower personal emotional adjustment to college. Specifically, this study also indicated that Facebook use and attitude toward Facebook were negatively correlated with personal emotional adjustment to college. The findings suggest that having a lot of

Facebook use and strong attitude toward Facebook tend to be low personal emotional adjustment to college. Kalpidou et al., (2011) indicated that students with many Facebook friends reported experiencing lower emotional adjustment in college. Moreover, Labrague, L. J. (2014) found that time spent on Facebook use correlated significantly with three emotional states (depression, anxiety, and stress). Moody, E (2001) reported that high levels of Internet use (i.e., time) were associated with low levels of social loneliness and higher levels of emotional loneliness (i.e., lack of intimate relationships), suggesting that online interactions fail to satisfy one's need for emotional connections in social interactions. Thus, the result was consistent with previous findings.

In addition, the present study tested the third hypothesis: (there will be a positive relationship between Facebook intensity and social adjustment to college). The result indicated that there was positive correlation between Facebook intensity and social adjustment to college (r = .20**). Thus, hypothesis 3 was supported. The result suggest that the more use of Facebook intensity tend to be higher social adjustment to college. Separately, the findings also found that attitude toward Facebook was positively correlated with social adjustment to college but Facebook use was not correlated with social adjustment to college. The research findings also suggest that strong attitude toward Facebook tend to be high social adjustment to college, however the number of Facebook use was not related to social adjustment to college. Kalpidou et al., (2011) reported that Facebook is a valuable venue not only for creating new and maintaining old relationship but also for being informed about social events that occur in University. Moreover, Passarella and Terenzini (1991) explained socialization as the process of being exposed to and taking on some of the new values, attitudes, beliefs and perspectives to which one is exposed at university. Social Network Sites such as Facebook were built to support relationship maintenance, and articulated connections (Friends) on these sites tend to reflect offline relationships Boyd & Ellison, (2007).Ellison, Steinfield, & Lampe, (2011) suggests that college students are using Facebook to engage in "social information-seeking," or finding out more information about others around them. Moreover, Heiberger & Harper, (2008) also found that social media sites such as Facebook enable students to interact with other students and faculty and to find and share information related to extracurricular activities and group socializations. Thus, the research finding was consistent with previous findings.

The present study also tested the hypothesis four: "there will be a negative relationship between Facebook intensity and academic adjustment to college". The result of this study found that there was no correlation between Facebook intensity and academic adjustment to college. Thus, hypothesis 4 was not supported. In general, the result also revealed that there was negative correlation between Facebook use and academic adjustment to college, however attitudes toward Facebook was not correlated with academic adjustment to college. The result suggests that having a lot of Facebook use tend to be low academic adjustment but attitudes toward Facebook was not related to academic adjustment to college. Junco (2011) found that Facebook use by college students also had the potential to be negatively associated with student engagement. Time spent using Facebook was positively associated with time spent participating in co-curricular activities but negatively related to student engagement, as measured by the National Survey of Student Engagement scale. Moreover, Van Eman (2009) regarded academic adjustments as having dimensions such as attitudes toward school and teachers to classes, academic self-concept, purpose and motivation/self-regulation. This leads us to focus on the negative influences of social media that might have been cause on students who seems to have isolated themselves in their own constructed private spaces, profiles or walls instead of being involved in the general offline on-campus social, academic and spiritual activities. Research results are similar to previous findings.

Secondly, the present study examined the correlation between student's adaptation to college and its predictor namely, self-esteem, the number of Facebook, time spent on Facebook, emotional and social connection to Facebook by regression analysis. The finding of this study suggested that there is the relationship between personal emotional adjustment to college and self-esteem, time spent on Facebook, emotional and social connection to Facebook. In general, we can conclude that if the students have the higher self-esteem, fewer amount of time spent on Facebook, lower emotional and social connection to Facebook, the more they adapt for personal emotional adjustment. The result also suggested that there is the relationship between social adjustment to college and self-esteem, emotional and social connection to Facebook. In general, we can also conclude that if the higher self-esteem, higher emotional and social connection to Facebook, the more adapt for social adjustment to college. Moreover, the present study proposed the relationship between academic adjustment to college and self-esteem and the number of Facebook friends. We can also conclude that if the higher self-esteem, fewer Facebook friends, the more they adapt for academic adjustment to college. Finally, the finding also suggested the relationship between attachment to institution and self-esteem and online friends. In general, we can conclude that the higher self-esteem, fewer online friends, the more they adapt for attachment to institution.

Furthermore, results indicated that fresher students who have "0-100" Facebook friends mostly used Facebook. Moreover, students who have "0-100" offline friends mostly used Facebook in both fresher and senior students. Furthermore, senior students who have "more than 400" Facebook friends mostly used Facebook. Researchers agree that the meaning of a Facebook friend is uncertain. Parks (1996) estimated that people maintain about 10-20 close relationships using traditional communication means. This number is phenomenally higher on virtual social networks. Kalpidou et al., (2011) listed an average of 200-250 Friends, but this number might have been even higher if participants reported the actual number of friends instead of a choosing a range of number of friends. Results are also similar with previous findings. ln the use of Facebook hours, both fresher and senior students were mostly used "0-2" hours on Facebook every day. This result is higher than the 10-30 minutes that Ellison et al (2007) reported, but is consistent with studies being carries out more recently (Kalpidou et al., 2011). According to Ellison et al, although one would expect that investing time in Facebook limits the time one has to socialize and study, the current result suggest that it is what you do while on Facebook that really matters. Thus, study support that the primary motive to use Facebook is to keep in touch with old friend and make new ones.

Finally, this study tested the hypothesis five: (fresher and senior students are different in Facebook use and attitudes toward Facebook). The results indicated that the differences between two groups in the number of Facebook friends ($F= 7.42$, $p<0.05$) and emotional connectional connection to Facebook ($F= 13.37$, $p<0.01$) and social connection to Facebook ($F= 7.82$, $p<0.05$). There are no differences in two groups for time spent on Facebook and the number of offline friends. Research findings also suggest that senior students had more friends than fresher students and fresher students reported a stronger emotional and social connection to Facebook than those of senior students did. This, findings are consistent with (Kalpidou et al., 2011) indicated that upper class students reported having significantly more friends than first year students did. On the other hand, first year students reported a stronger emotional connection to Facebook than upper class students did. Kalpidou et al., (2011) reported that the construct of emotional adjustment reflects the student's ability to balance stresses related to college life and maintaining a sense of doing will. It is possible that students seek out friends on Facebook as a coping strategy to relieve the stress of college adjustment. Kalpidou et al., (2011) also reported that Facebook is a valuable venue not only for creating new and maintaining old relationship but also for being informed about social events that occur in University. Moreover, students could use Facebook to benefit by creating

opportunities to connect their students with each other and with university life activities. The results are consistent with previous studies. Thus, hypothesis 5 was supported.

Conclusion

This study is concerned with an attempt to explore the effect of Facebook intensity on self-esteem and student's adaptation to college. Specifically, the focus of present study is the roles of Facebook intensity (Facebook use and attitude towards Facebook) on self-esteem and student's adaptation to college (personal-emotional adjustment, social adjustment, academic adjustment and attachment to institution) among Monywa University students.

This study also attempted to develop the Myanmar version of the Facebook Intensity Scale, based on a translation of the Ellison-et al., (2007) original instrument. According to the results of reliability analysis, the reliability coefficients were found to be .70 for the Facebook Intensity (total), .74 for the emotional connection to Facebook and .63 for the social connection to Facebook respectively.

In addition, we developed the Self-Esteem Scale based on the original measure of the Rosenberg Self-Esteem Scale (1965). Rosenberg devised the Rosenberg Self-Esteem Scale to evaluate the self-worth and self-acceptance. The reliability coefficient of the Rosenberg Self-Esteem Scale was found to be .69. According to the results, the self-esteem scale is a reliable test for the Myanmar cultural setting.

Furthermore, we attempted to develop the Student Adaptation to College Questionnaire (SACQ) intended to measure college adjustment. The value of reliability coefficient were found to be .88 for SACQ total, .82 for the academic adjustment scale, .76 for the personal emotional adjustment, .76 for the institutional attachment and .76 for the social adjustment. So, these tests are relatively good internal consistency.

In order to test the research hypotheses, Pearson correlation analysis was used to examine the correlation between Facebook intensity on self-esteem and student's adaptation to college. Moreover, each multiple regression was run to predict each dependent variable: Personal-emotional Adjustment, Social Adjustment, Academic Adjustment and Attachment to Institution) from Self-esteem, Amount of Facebook Friend, Time spent on Facebook, Social connection to Facebook, and Emotional Connection to Facebook. Further, oneway analysis of variance was conducted to analyze the differences between fresher students and senior students in Facebook use and attitudes toward Facebook.

According to the results, the research found that there is no correlation between self-esteem and Facebook intensity. But, the self-esteem is important for the Student's Adaptation to College. According to the results of the regression and R^2s, 15 percent of the variance of Personal-emotional adjustment, 19 percent of the variance of Social adjustment, 22 percent of variance of Academic adjustment and 12 percent of variance of Attachment to institution are accounted for, or determined by Self-esteem, Amount of Facebook Friend, Time spent on Facebook, Social connection to Facebook, and Emotional Connection to Facebook in combination.

The result of this study found that there was negative correlation between Facebook intensity and personal emotional adjustment to college (r -.20**). Our result suggests that the more use of Facebook intensity, the lower personal emotional adjustment to college. Specifically, this study also indicated that Facebook use and attitude toward Facebook were negatively correlated with personal emotional adjustment to college. The findings suggest that having a lot of Facebook use and strong attitude toward Facebook tend to be low personal emotional adjustment to college.

The result indicated that there was positive correlation between Facebook intensity and social adjustment to college (r = the result suggest that the more use of Facebook intensity tend to be higher social adjustment to college. Separately, the findings also found that attitude toward Facebook was positively correlated with social adjustment to college but Facebook use was not correlated with social adjustment to college. The research findings also suggest that strong attitude toward Facebook tend to be high social adjustment to college, however the number of Facebook use was not related to social adjustment to college.

The result of this study found that there was no correlation between Facebook intensity and academic adjustment to college. In general, the result also revealed that there was negative correlation between Facebook use and academic adjustment to college, however attitudes toward Facebook was not correlated with academic adjustment to college. The result suggests that having a lot of Facebook use tend to be low academic adjustment but attitudes toward Facebook vas not related to academic adjustment to college.

This result suggests that senior students have significantly more friends than fresher students did. It was also found that fresher students have strongly emotional connection to Facebook and social connection to Facebook than those of senior students did. Research findings suggest that attitude toward Facebook was also important factor for social connections and social activities offered on campus.

In conclusion, Facebook is no effect on self-esteem in this study. But, our result suggests that self-esteem is an important factor for college adjustment. Moreover, the more use of Facebook intensity, the personal emotional adjustment. Furthermore, this finding also indicate that the Facebook Intensity, the lower the Personal-emotional adjustment but the higher Social adjustment. Specifically, having a lot of Facebook use lead to low academic Finally, the result proposes. That the senior students are more friends than fresher students but fresher students have strongly emotional connection to Facebook and social connection to Facebook than those of senior students did.

Limitations and directions for future research

Although the findings of this study are useful, it has several limitations and needs further research. Firstly, the sample size of this study was small to make any generalization, only 400 undergraduate students. Secondly, this study was carried out only undergraduate students in Monywa University. The findings of this study should be cautiously applied because the sample of the study might not represent the general undergraduate population in Myanmar. Future research should include a large sample size not limited to only undergraduate students from one particular University.

In addition, the above limitations, the reader is also reminded that the current study was exploratory and that more systematic investigation of the research question with larger sample sizes and with different year groups is warranted. Furthermore, we also emphasize that the wording of the Facebook intensity item was modified. This may reduce comparability of results to prior research, but we think is unlikely. Given that the survey was self-report and actual behavior was not observed, it is also possible that social desirability may have influenced the results.

As with all correlational designs, the relationships between Facebook intensity and student contingent self-esteem cannot be determined. It is not possible to determine whether Facebook intensity increases student contingent self-esteem or whether student contingent self-esteem increases Facebook intensity. Student contingent self-esteem may become more or less valued as college and University students transition through other stage of life. Our measure of Facebook

intensity (Ellison, et al., 2007) was a general self-report measure. Further experimental methods may explore these questions in the future; especially considering many of our correlations would be classified as weak to moderate in terms of their strength.

Finally, future research should utilize implicit measure to counter any social desirability effects that may arise. Moreover, future research should investigate the notion of Facebook friend, personality traits of profile 0%ners, as well as the content of the profiles using path analyses to clarify further the effects of Facebook on college adjustment.

Implications

The findings of this study will contribute to an increased awareness of adjustment problems faces by University students. And this study offers insights which can help university management, academic staff and students support services intervene in the process of helping students to quickly adjust to the university's academic and social demands.

Specialty, our result suggests that if the more use of Facebook intensity, the lower personal emotional adjustment to college but the higher social adjustment to college. Moreover, our findings also might have two educational implications specifically related to the use of Facebook. First, one of the findings of the study indicates that strong attitude toward Facebook tend to be high social adjustment to college. Second, Facebook use has a negative impact on academic adjustment.

Based on this finding, education policy makers may consider using social network sites for their own university. Moreover, educators and University administrative staff can provide students with academic and emotional support after class by using social network sites.

Finally, the implications from this research, the findings do contribute to the literature for future research and also a stepping stone framework for future studies by other researcher. In its contribution to theoretical implication, Facebook use and attitudes towards Facebook do impact emotional adjustment, academic adjustment, attachment to institution and social adjustment.

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MANGROVE CONSERVATION EFFORTS IN MYANMAR: AYEYARWADY AND RAKHINE

ل-ا MANGROVE CONSERVATION EFFORTS IN MYANMAR: AYEYARWADY AND RAKHINE

Hein Myat Thu*

Abstract

In Myanmar, mangrove forests are mainly found in three geographical regions, especially the Ayeyarwady Delta, and Rakhine and Tanintharyi Coasts. Mangrove plays a vital role not only for the livelihoods of coastal people but also for environmental services. Mangrove provides shelter and habitat to diverse wildlife, estuarine and near shore fisheries. Mangroves were degraded in Myanmar, especially in the Ayeyarwady Delta and Rakhine State. The successive governments have focused on agricultural and economic development of the country. Moreover, due to the population growth, mangrove forests were cleared to meet their needs. Since mangroves forests help to mitigate the effects of climatic change and the natural heritage of the country, the governments have attempted to conserve sustainability of mangroves for generations. In collaboration with the United Nations Development Programme (UNDP) and the Food and Agricultural Organization (FAO), the Forest Department (FD) started UNDP/FAO projects in 1991. In 1995, the National Forest Policy was formulated to ensure sustainable development of forest resources. The Cyclone Nargis struck Myanmar on 2 May 2008 and devastated quite a number of Ayeyarwady mangroves. The FD in collaboration with NGOs and IGOs/INGOs conducted their tasks for community development and protection and conservation of mangrove systematically through community participation before and after 2008. This research aims to contribute the findings for the development of mangrove conservation which helps not only to be safeguarding the natural ecosystems but also to poverty alleviation in Myanmar. This research analyzes three things: the factors that cause the mangroves degradation, the collaboration among the Government agencies, NGOs/IGOs/INGOs and local communities and, the methods of mangrove forests conservation.

Keywords: FD, NGOs, IGOs/INGOs, FUGs, CF, RF, Conservation

Introduction

Myanmar is bestowed with vital forests and wetlands, which are the country's major natural wealth. Myanmar's 2014 census revealed that the country's population reached over 51 million in 2014. Seventy percent of them resided in rural areas and depended on the resources. Myanmar has faced mangrove degradation, especially in the Ayeyarwady Delta and Rakhine State. In these areas, the causes of mangroves degradation are extension of paddy cultivation lands, encroachment of illegal shrimp ponds, overproduction of fuel-wood and charcoal, extension of salt-pan areas and intrusion of garden land and human settlement. Moreover, mangroves were depleted due to Cyclone Nargis in 2008 and Cyclone Giri in 2010 in these areas. Therefore, it is necessary to rehabilitate the mangrove forests. The scope of this paper is to focus on the collaboration among the Forest Department (FD), the Non-governmental Organizations (NGOs), the Intergovernmental Organizations (IGOs) and the International Non-governmental Organizations (INGOs) for Mangrove Conservation Efforts in Myanmar: Ayeyarwady Region and Rakhine State. The FD established many mangrove plantations to meet the needs of the local communities in Ayeyarwady Region and Rakhine State. The FD implemented the regeneration of mangrove forest projects in cooperation with the NGOs and IGOs/INGOs.

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Situation of Mangroves

Myanmar, one of the Southeast Asian countries, occupies a large coverage of mangroves in the three areas- Ayeyarwady Delta, Rakhine State, and Tanintharyi Region. Mangrove forests covered 732,522 acres in the Ayeyarwady Delta, 413,850 acres in Rakhine State and 482,099 acres in Tanintharyi Region in 1980 respectively. In 2015, there were remained 194,925 acres of mangrove forests in the Ayeyarwady Delta, 313,792 acres in Rakhine State and 635,266 acres in Tanintharyi Region. Therefore, the total 484,488 acres of mangrove forests area disappeared in three areas during the period of thirty-five years. The following Table (1) shows occurrence of mangroves in three areas in 1980 and in 2015.

Table 1 Mangrove forests occurrence in three areas in Myanmar between 1980 and 2015

No	State/Region	1980 (acres)	2015 (acres)	Remark
1	Ayeyarwady Region	732,522	194,925	Coastal and Delta
2	Rakhine State	413,850	313,792	Coastal
3	Tanintharyi Region	482,099	635,266	Coastal
	Total	**1,628,471**	**1,143,983**	

Source: *Ministry of Environmental Conservation and Forestry, Forest Department (FD), Mangrove Data (Abstract),* Yangon, 2015

One of the major causes for mangrove depletion in the Ayeyarwady Delta was rapid population growth, which led to change in land-use and over-utilization of resources. The local communities heavily utilized mangrove forests as a source of fuel wood and charcoal for Yangon between 1970 and 1992[1]. In 1980, many of the dense mangroves were cleared and rice production was the government's priority. The World Bank provided loans for the paddy I and paddy II projects and the mangroves were cut and converted into paddy cultivation. Similarly, to be able to produce sufficient domestic consumption and export, the Department of Fisheries encouraged extensive culture system and extensive plus culture system in coastal areas especially in the Rakhine Coast in 1998[2].

Forest Management in Myanmar

In Myanmar, the Forest Policy was formulated in 1995 in accordance with the forestry principles adopted at the United Nations Conference on Environment and Development (UNCED). The 1995 Myanmar Forest Policy formalized the commitment and intent of the government to ensure the sustainable development of forest resources for social, environmental and economic purposes. The policy paved the way for prudent use and enhanced benefits from the forest while maintaining ecosystem integrity and environmental balance. Six imperatives identified in the policy are:

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[1] ***Sustainable Forest Guidelines***, Yangon, Forest Department (FD), February, 2000, p.229 (Hereafter this work will be referred to as ***Forest Guidelines***, Yangon, FD, February, 2000)

[2] U Win Maung, Project Manager, ***Worldview International Foundation***, Director of Forestry Department (Retd), Yangon, ***Interview by Author***, 22 March 2017 at his office

(1) Protection of soil, water, wildlife, biodiversity, and environment

(2) Sustainability of forest resources to ensure perpetual supply of both tangible and intangible benefits accrued from the forests for present and future generations

(3) Basic needs of the people for fuel, shelter, food, and recreation

(4) Efficiency to harness in the socio- environmentally friendly manager, the full economic potential of the forest resources

(5) Participation of the people in the conservation and utilization of the forests

(6) Public awareness about the vital role of the forest in the well-being socioeconomic development of the nation[1].

In 2013, the FD drew the 2013 Myanmar Mangrove Bill for mangrove conservation and rehabilitation based on the 1995 Myanmar Forest Policy, measures for mangrove forest management, policies being practiced in mangrove forest administration task of the Philippines and national level land utilization policy of Belize in Central America. It is believed that if Mangrove Laws were enacted by the FD, mangroves could be managed systematically. Moreover, the FD needs to cooperate with the local communities in the mangrove rehabilitation activities for sustainability of mangrove and livelihood development[2].

In 2018, the former 1992 Forest Law was replaced with the New Forest Law which promulgated by the Pyitaungsu Hluttaw. Hence, the 2018 Forest Law came into force on 20, September, 2018. The 2018 Forest Law comprised 13 Chapters and 58 Sections. The 2018 Forest Law proved the legal framework to implement forest policies, and its aims include (1) to implement the forestry policy of the government, (2) to implement the environment conservation policy of the government, (3) to promote the sector of public cooperation, (4) to carry out in line with international agreements relating to conservation of forests, conservation of natural resources and environmental protection, and global climate change, reduction of natural disasters, (5) to contribute towards the fuel requirement of the communities, and (6) to implement sustainable forest management which support the Sustainable Development Goals (SDGs)[3]. Carrying out global climatic changes and the SDGs are the significant factors in the 2018 Forest Law. These aims highlight that Daw Aung San Suu Kyi government confirmed its commitment to protect the planet through sustainable natural resources management and environmental protection. Moreover, the government pledged to implement the tasks of economic development in parallel with the environmental conservation[4].

In addition, under the 2018 Forest Law, the government took more serious legal actions against the offences rather than the 1992 Forest Law. For example, in the 1992 Forest Law, if the person or group or organization commits the act on trespassing and encroaching settlement and pasturing domestic animals in the Reserved Forest (RF), the criminal will be punished with a fine up to 5,000 kyats or with imprisonment up to six months or with both. But, the 2018 Forest Law

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[1] ***The 1995 Myanmar Forest Policy***, Yangon, Forest Department (FD), Ministry of Forestry, 1995, pp.3-5 (Hereafter this work will be referred to as ***Myanmar Forest Policy***.)

[2] U Khin Maung Oo, Director, Forest Department, ***Necessary Basis Causes for Mangrove Law Enactment and Mangrove Conservation Branch Opening***, Yangon, Ministry of Environmental Conservation and Forestry (MOECAF), 8, August, 2013, p.25

[3] The Forest Law of 2018, ***The Global New Light of Myanmar***, Yangon, News and Periodical Enterprise, 21, September, 2018, p.3 (Hereafter this work will be referred to as ***Forest Law of 2018, GNLOM, 2018***.)

[4] The Global New Light of Myanmar, Yangon, News and Periodical Enterprise, 9, October, 2018, p.4

expressed that if the person or group or organization commits the act on trespassing and encroaching settlement and pasturing domestic animals in the RF, the offence will be charged with a fine up to 300,000 kyats or with imprisonment up to one year or with both[1]. To protect degradation of forest, the government enacted the 2018 Forest Law in September 2018. Therefore, the people should follow the law to implement sustainable forest management.

Forest policy, legal instruments and institutional frameworks are adopted in accordance with the principles of sustainable development. The sustainable forest management is needed to sustain development for forest resources. The strategies and actions plans recommended are expected to be useful for current and future developments which are run by the decision makers in the national level.

Activities of Forest Department (FD) and Community Forestry (CF)

The FD is the main arm of the Government for forest sector policy and programme implementation. The 1992 Forest Law supported the 1995 Community Forestry (CF) in Myanmar. The 1992 Forest Law demonstrated a shift from the concept of revenue generation and restriction to motivation and share of management responsibilities with people's participation. It provided opportunities for the promotion of private sector involvement in the forestry sector. It encouraged community participatory approach in managing the forest resources[2].

The public involvement is essential for mangrove forest management and conservation and this will probably help make sustainable forest management in the future. Therefore, it is necessary to encourage the public participation in mangrove forests management and conservation. All people of the seasonal settlement in mangrove forest areas were the main users. They should participate in all aspects of the mangrove management. They need to protect their mangrove resources with traditional knowledge. But, mangrove resources cannot be managed without the participation of the local communities. In the absence of their participation, mangrove degradation issues could not be solved[3].

With the support of the 1992 Forest Law, the FD initiated the Community Forestry (CF) as well as issued the Community Forestry Instructions (CFIs) in 1995. According to the 1995 CFIs, the CF was (1) establishment of wood lots where there is an insufficient fuel-wood and other product for community use and (2) plantation of trees and exploiting of forest products to obtain food supplies, consumer products and incomes at farmer's level.

Challenges in implementation of the CF were illegal cutting in community forests, and encroachment into community forests for the purpose of agriculture and shrimp farming. Moreover, some local people had no interest in the CF. On the other hand, some local community searched for crabs and shrimps in the community plantation. In addition, law enforcement was weak in taking proper actions to those who violate the rule. Some forest staff did not understand on concept and process of CF. Under the procedure for the 1995 CF, the villagers did not understand how to practice because they have no experience. Lack of fund and qualified staff were also the constraints in implementation of the CF. However, the NGOs and IGOs/INGOs have

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[1] Forest Law of 2018, GNLOM, 2018, p.8

[2] Forest Law of 1992, The State Law and Order Restoration Council, 1992, p.11

[3] U Ohn, Kogo Motohiko, Maung Maung Than, Kyaw Nyein, Nyi Nyi Kyaw, Kyaw Aye, ***Ten years in Pyindaye, Restoration of Mangrove Ecosystems and Community Development, Ayeyaewaddy Delta, Myanmar, 1999-2008***, Yangon, FREDA and ACTMANG, May, 2012, pp.57, 79 (Hereafter this work will be referred to as **"Ohn, Kogo, Maung, Kyaw, Nyi and Aye; *Ten years in Pyindaye, Restoration of Mangrove Ecosystems and Community Development, 1999-2008*".**)

played a key role to promote the CF. In 2016, the minister of Ministry of Environment Conservation and Forestry (MOECAF) replaced the 2016 CFIs. It was to reflect changing requirements.

In 2016, the new CFIs replaced the 1995 CFIs. Therefore, the 2016 CFIs was enforced on 16 August 2016. According to the 2016 CFIs, the CF was defined as forestry operations in which the local community itself was involved in sustainable forest management and utilization. The Forest Users' Groups (FUGs) defined households irrespectively of status, ethnicity and religion have the right to join a CF user group if they live within five miles of forest areas for five years continuously. According to 2016 CFIs, the duties of the FUGs were (1) to be carried out to improve existing forests or establishment of plantations in line with the management of the CF, (2) to be carried out management and utilization to be sustainable Community Forestry, and (3) to be protected extraction and encroachment from the outsiders in the Community Forestry area, in conducting these protection, to get help from the FD and related departments.

On the other hand, according to existing law, rules and regulations and procedures, the opportunities of the FUGs were (1) to establish the CF in RF area were free from lease of land utilization, (2) to accept the technology, equipment and financial assistances from internal and external organizations, (3) to extract wood and forest products systematically in accordance with management plans, and (4) to be claimed reparations for the cost of lose forest and crop plantations in which other plans conduct in the CF[1].

In compare with the 1995 CF and the 2016 CF, the 1995 CF emphasized on the forest conservation. Local communities had doubt about the 1995 CF. On the other hand, the 2016 CF highlighted the rights and interests of the local communities. Moreover, changing over from the 1995 CFIs to the 2016 CFIs enforced the 2018 Forest Law.

The FD has carried out mangrove plantation programmes in terms of restoration of mangroves and coastal forests. Moreover, the FD has worked in collaboration with the local communities and encouraged people's participation in planting activities. The FD planned to rehabilitate the mangrove forests through the CF, Private, Natural Regeneration (NR) and other programmes. Mangrove reforestation programmes in the Ayeyarwady Delta was as follows.

Table 2 Mangrove Reforestation Programmes in the Ayeyarwady Delta from 1981-82 to 2016-17

Region/Delta	Township	Mangrove Forest Areas (acres)			
		CF plantations	Private plantations	N/R plantations	Others plantations
Ayeyarwady	Bogalay	250	-	280	3,994
	Laputta	1,946	490	-	770
	Pyapon	3,767	2,145	-	305
Total		**5,963**	**2,635**	**280**	**5,069**

CF- Community Forestry, N/R- Natural Regeneration

Source: ***Mangrove Data (Abstract),*** Naypyidaw, Forest Department (FD), Ministry of Natural Resources and Environmental Conservation (MONREC), February, 2017

Table (2) shows that mangrove reforestation of the CF, Private, N/R and other programmes were planted in Bogalay, Laputta and Pyapon Townships, Ayeyarwady Delta from 1981-82 to 2016-17. According to the Table (2), the total 5,963 acres of mangrove plantations were planted

[1] CFIs, FD,2016.pp.1-15

by the FD in order to establish the CF. To promote community participation in mangrove restoration programmes, the FD allowed establishment of 2,635 acres of private forest in Laputta and Pyapon Townships. The FD also established about 280 acres of natural regeneration plantations in Bogalay. Moreover, in collaboration with the Japan International Cooperation Agency (JICA), Forest Resource Environment Development and Conservation Association (FREDA) and Myanmar Environmental Conservation and Rehabilitation Network (MERN), the FD established about 5,069 acres of other plantations in Bogalay, Laputta and Pyapon Townships as protected areas.

Concerning the sector of CF in Rakhine State, from 2000 to 2003, with the help of the FD, nine hundred and twenty-three FUGs established 855.07 acres of natural forest for the CF in twenty-two villages, Maung Daw Township. In Buthi Daung Township, about 757.00 acres of mangrove plantation and natural forest were established by 904 FUGs from twenty-four villages. Therefore, the Community Forestry Certificates were issued by the FD to 1827 FUGs to conserve the total area 1,612.07 acres of mangrove forests in Rakhine State from 2000 to 2003. The Table (3) shows that the CF plantations were established in Maung Daw District, Rakhine State from 2000 to 2003.

Table 3 Community Forestry (CF) plantations established in Maung Daw District, Rakhine State from 2000 to 2003

Unit: acres

No	Township	FUGs number	Reserved Forest (RF)		Protected Public Forest		Total
			Plantation	Natural	Plantation	Natural	
1.	**Maung Daw**	923	-	325.20	-	529.87	**855.07**
2.	**Buthi aung**	904	-	10.00	380.00	367.00	**757.00**
Total		**1827**		**335.20**	**380.00**	**896.87**	**1,612.07**

Source: ***Forest Department (FD), Rakhine State***

Cooperation with NGOs

The FD closely cooperated with Non-governmental Organizations (NGOs). FREDA is a non-political, non-profit and non-governmental organization in the forest sector of Myanmar. It was established in 1996. In cooperation with FD, FUGs, Action for Mangrove Reforestation (ACTMANG) and Tokio Marine (T2M), FREDA conducted the Mangrove Reforestation Project through community participation in Pyindaye Reserved Forest (RF), Ayeyarwady Delta in 1999. The aim of the project was to recover mangrove forests in Pyindaye RF where deforestation has been increased year by year in an alarming rate. As long as mangroves recover, original mangrove ecosystem could restore for the sake of communities in Pyindaye. On the other hand, it was anticipated to absorb carbon that partly causes global warming through mangrove reforestation.

Table 4 Establishment of Community Forestry Mangrove plantation in Pyindaye RF, Pyapon Township from 1999 to 2008

Phase (I) **Unit: acres**

Year	Village	HH	1999	2000	2001	2002	2003	Total
Area	10	310	126	350	375	400	263.5	**1514.5**

HH-Household

Phase (II) **Unit: acres**

Year	Village	HH	2004	2005	2006	2007	2008	Total
Area	12	375	533	388	260	250	250	**1681**

HH-Household

Source: ***Forest Resource Environment Development and Conservation Association (FREDA) office***, NGO, Yangon, 2015

The Table (4) mentioned that establishment of community forestry mangrove plantation in lower part of Pyindaye RF, Ama Sub-township, Pyapon Township, Ayeyarwady Delta, from 1999 to 2003. In phase I, the project completed 1,514.5 acres by 310 households of FUG member from 10 villages (OakPho Kwin Chaung, Tae Pin Seik, War Kone, Ka Nyin Kone, Khar Chin, Kyawe Tae, MaMhwe Kwin, 2-Ba Wa Thit, 3-Ba Wa Thit and Padauk Pin Seik). In phase II, project from 2004 to 2008, the area of 1,681 acres was established by 375 households of FUG from 12 villages (OakPho Kwin Chaung, War Kone, Ka Nyin Kone, Kyawe Tae, MaMhwe Kwin, 2-Ba Wa Thit, ThaMein PaLae, Padauk Pin Seik, War Pa Nar, U Pae, A Shae Phyar and 3-Ba Wa Thit). Therefore, a total of 3,195.5 acres were successfully reforested by the CF within ten years.[1]

During the year 2007, with the financial support of Diakonie Katastrophenhilfe (DKH), Germany about 200 acres of mangrove plantations including Byushwewa (*Bruguiera sexangualar*), Thamegyi (*Avicennia officinalis*) and Kanaso (Ye) (*Heritiera fomes*) were established in Kadonkani RF. Similarly, additional 400 acres of mangrove plantations were established in the same RF in 2008 and 2009. The project area would serve as a model and inject stimulus to grow more and more mangrove trees by the community.[2]

During the Mangrove Reforestation Project; Phase III (2009-2013), the area of 1,550 acres was established by 146 households of FUGs from 17 villages (OakPho Kwin Chaung, Tae Pin Seik, War Kone, Ka Nyin Kone, Kyawe Tae, 2-Ba Wa Thit, 3-Ba Wa Thit, Lay Pin Chaung, Padauk Pin Seik, Nauk Pyan Toe, ThaMein PaLae, War Pa Nar, U Pae, Kyauk Tine, Ba Aye Kan Kye, Aung Kone, and Pho Htoo Taung Ya. Moreover, in 2017, Community Forestry Certificates were issued to 1,083 FUGs from 22 villages who proposed about 10,278 acres of plantations to the FD in Pyapon Township (Ama Sub-Township) with the support of FREDA for 30 years. In 2018, in collaboration with the FD, FUGs, ACTMANG, and T2M, FREDA continuously implemented the Mangrove Reforestation Project through the community participation in Pyindaye RF, Ayeyarwady Delta. After the project, area of mangrove plantations 375 acres and mangrove seedlings 347,000 were established by 736 households of FUGs from 16 villages in the target area.[3]

Mangrove Service Network (MSN) is a local NGO working in participation with the Government Organizations, local and INGO communities in mangrove conservation programmes which was established in December 2001. MSN cooperation with United Nations Development Programme (UNDP) and Food and Agricultural Organization (FAO) carried out the Sustainable Livelihood Development Project in the Ayeyarwady Delta under Human Development Initiative Programme from 1994 to 2001. The project established mangrove plantations 1200 acres in 360 villages under the CF programme.

MSN, implemented a small project on Ecological Mangrove Restoration by necessary technical assistant of Mangrove Action Project (MAP) in Pyinalan RF in collaboration with the FD in Laputta Township, was started in 2006. The project was provided by financial support from

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[1] **Ohn, Kogo, Maung, Kyaw, Nyi and Aye;** ***Ten years in Pyindaye, Restoration of Mangrove Ecosystems and Community Development, 1999-2008*****",** pp.57,79

[2] Natural Environment Conservation, available at http://fredamyanmar.com/partnetship%20 development.html

[3] ***Forest Resource Environment Development and Conservation Association (FREDA) office***, NGO, Yangon, 2019

Global Green Grant (GGG). The cost of project was US dollar 2500.00. The project period was four-year. The objectives of the Ecological Mangrove Restoration Project were to observe the nature of mangroves regeneration in the Ayeyarwady Delta, to demonstrate Ecological Mangrove Restoration and to promote mangrove conservation activities in the region. The target area was 100 acres in the Block number (62) in Pyinalan RF, Laputta Township. Before implementation of the project, the area was old traditional shrimp pond kept back by the FD. The land was flat plain and totally dry and clear. In surrounding area dominant species were Madama (*Ceriops decandra*), Tayaw (*Excoecaria agallocha*), Thamegyi (*Avicennia officinalis*), Rhizophora spp: Kyana (*Xylocapus mluccensis*) and Kantbalar (*Soneratia apetala*). Source of seeds and seedling were available within one mile radius of the project site. The Ecological mangrove restoration method was no need for a mangrove nursery or for planting of mangrove seedlings. The method used low-cost techniques. Moreover, the mangrove plantation growth rate was faster man-made plantation.[1]

Similarly, in Rakhine State, regarding mangrove conservation in cooperation with NGOs, the project entitled "Establishment of Community Nurseries and Plantations" was carried out by the MSN in 2008. This project was implemented in Kyae Taw and Jiro Pasig villages, Sittway Township. The project villages are situated at coast of Bay of Bengal, northern Rakhine State. The two areas are the most disaster-prone area of Myanmar. The two villages have been moved to inland area due to suffer from bank erosion about 3 times within the last 20 years. During the project implementation, trainings on technical assistant, feasibility survey activities, nursery activities (fresh water seedling nursery and mangrove nursery), self-made efficient stove making and technical monitoring and evolution were conducted by the MSN through the participation of villagers in the activities. The Malteser International Organization provided over US dollar 80000.00 million for the project. At the first time, with the supporting of the Malteser International Organization, the MSN established 10 acres plantations as Afforestation in Kyae Taw and Jiro Pasig villages. In 2011, villagers more participated in the second time mangrove planting activities due to seeing the progress of plantation and believing.[2] After the project implementation, coastal erosion was reduced in Kyae Taw and Jiro Pasig villages due to the establishing a mangrove wave-wind barrier from the project. Moreover, the local communities carried out breeding of prawn and crab in the mangrove areas that live on ones to meet the needs of their food, clothing and shelter.[3]

MERN, one of the Myanmar NGOs, was founded in 2009 after Nargis. MERN carried out Coastal Livelihood and Environmental Assets Restoration in Rakhine (CLEARR) project by the necessary assistant of Livelihood and Food Security Trust Fund (LIFT), in 42 villages, Gwa Township and Kyeintali Sub-township, Southern part of Rakhine from July 2011 to June 2014. The main objectives were (1) by collective efforts of the localities to conduct mangroves re-establishment and management smoothly, (2) by supporting agriculture and livelihood to promote food and livelihood opportunities for the local people and (3) to raise needed capacity for environmental management and livelihood development. About 30 acres of mangrove plantations in Ponnyet, 100 acres in Kyaukkyi, 100 acres in Ywarthit and 100 acres in Gwa were planted. In 2014, Community Forestry Certificates were issued to forty-four FUGs to conserve some 7,837

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[1] *Progress Report on Ecological Mangrove Restoration Project in the Ayeyarwady Delta*, ***Yangon, Mangrove Service Network (MSN), July 2006, pp.1,3***

[2] U Win Sein Naing, Chairman, Mangrove Service Network (MSN), ***Establishment of Community Nurseries and Plantations Project***, "Mangrove Seminar", Yangon, 2018

[3] U Win Sein Naing, Chairman, Mangrove Service Network (MSN), Yangon, ***Interview by Author***, 22 February 2018 at his office

acres of mangrove species in Kyeintali Sub-township and Gwa Township. LIFT contributed 3 million US dollar to the project.[1]

Moreover, some 124 acres of mangrove plantations in Byne Kyun, over 100 acres in Wit Thoe Kyun and about 0.75 acres in Thone Bo in which twenty-five mangrove species such as Hnanbyu (*Bruguiera parviflora*), Byuoaksaung (*Bruguiera gymnorhiza*), Byu-Chedauk-Apho (*Rhizophora sp*), Madama (*Ceriops decadra*) and Thamegyi (*Avicennia officinalis*) were established between 2012 and 2015 respectively. The aims of the project were natural disaster conservation, sufficient food, clothing and shelter of fishermen, conservation of climatic changes and development of ecotourism in these areas. During the project period, the MERN conducted mangrove seedlings trainings and trainings on marine ornaments such as rings, necklaces, bracelets to the local communities for their economic development. LIFT provided ten million Kyats for the project.[2]

Rakhine Coastal Region Conservation Association (RCA) is a local NGO which established in 1987. In 2006, the RCA conducted Coastal Conservation Initiative in Rakhine State project in Kyeintali Township, Rakhine State. The RCA also implemented Coastal Environmental Sustainability (CES) project in Kyeintali Township from 2010 to 2013. The goal of the project was public awareness, protection of big mangrove trees, protection of sand dune forest: casurina, plantation of mangrove in bare sandy land, plantation of windbreak forest, protection of wetland birds and establishment of mangrove forest near EEC. Concerning the project, the LIFT provided US dollar 3 million to RCA Organization. By supporting from the LIFT, about 200 acres of mangrove plantations were established by 51 households of the FUGs in Kyin Gyi village, Kyeintali Township.

The RCA continuously implemented SCALE UP Community Forestry in Myanmar (SU Com For) project in Gwa Township from 2015 to 2017. The project aims human awareness of importance of mangrove forests, harmony with the survival of local communities and educative talks to increase the awareness of the posterity or new generation about the importance of mangrove forests. During the project implementation period, it provided training courses on mangrove saplings, management of mangrove, financial management and the wives to get extra income (making handmade furniture and doing manageable live-stock breeding) while their husbands went out to protect mangrove forests. The Regional Community Forestry Training Center (RECOFTC) contributed US dollar 2 million to the project. With the supporting of the RECOFTC, the RCA planted some 20 acres of mangrove plantations in Laungkyoe village, Gwa Township, Rakhine State.[3]

Cooperation with IGOs and INGOs

For mangroves rehabilitation and conservation, the FD on its part has started the establishment of mangrove plantations since 1980s. In the sector of the cooperation with IGOs/INGOs in the Ayeyarwady Delta, the FD in collaboration UNDP and FAO had undertaken the Feasibility Study on Mangrove Reforestation (MYA/90/003) Project from 1991 to 1993. The possibility of forming mangrove nurseries for large scale plantations was investigated and species trial plantations were established. This MYA/90/003 project was initiated at the request of the Government of Myanmar (GOM) to redress the growing fuel-wood supply-demand imbalance in

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[1] U Win Maung, Project Manager, ***Worldview International Foundation***, Director of Forestry Department (Retd), Yangon, ***Interview by Author***, 3 January 2017 at his office

[2] U Than Win, Chairman of Village Development Committee, Gwa Township, Rakhine State, ***Interview by Author***, 12 March 2018 at his office

[3] U Myint Aung, RCA member, Local Coordinator for DAFNE project, Kyeintali Township, Rakhine State, ***Interview by Author***, 25 April 2018 at his office

the Ayeyarwady Delta and to develop the planting technology needed to rehabilitate degraded and denuded areas to conserve the mangrove environment and enhance its protective functions. The objectives of the project were to initiate mangrove studies, species trials, pilot plantations to rehabilitation critically degraded mangrove areas in selected sites within the Ayeyarwady Delta. UNDP and FAO contributed US dollar 328,250 for the project. The GOM provided kyat 2,054,990. Two experimental trial plantings of 75 acres and 100 acres were successfully established in Bogalay and Laputta townships respectively.[1]

Moreover, four fellows were sent to Thailand and Malaysia to familiarize themselves with all aspects of mangrove management and charcoal processing. The technical and managerial capability of the Ayeyarwady staff at all levels has been considerably strengthened through on-side training as well as the fellowships provided.[2] The MYA/90/003 project outputs would contribute to the sustained use of mangrove wood and non-wood resources by enhancing skills, basic knowledge and awareness of the problem of mangrove degradation as well as by enhancing national capabilities to plan and rehabilitate degraded forests.[3]

With the experiences from (MYA/90/003) project, Community Development of Ayeyarwady Mangroves Project (MYA/93/026) was carried out to lay down the methodology to restore mangrove through people's participation. It was signed on 26 January 1994 by the Government of the Union of Myanmar, UNDP and FAO. This Project was during the period from 1994 to 1996. The development objective of this project was to promote sustainable human development by improving the socio-economic welfare of disadvantaged communities in critical areas in the Ayeyarwady Delta through mangrove environmental regeneration and protection, improved fisheries, income generation and sufficiency in fuel-wood and wood products.[4] UNDP and FAO contributed US dollar 2.006 million for the project. Government of Myanmar provided kyat 17.87 million.

A total of 50 project villages was selected in two townships (48 regular villages and two forest villages in RF area). Villagers raised 4,800 acres of plantations and planted 6.4 million seedlings, equivalent to 6,400 acres, along river banks and roadsides, while maintaining and protecting 1,400 acres of natural regeneration area. All together a forest area equivalent to 12,600 acres was established.[5]

The MYA/93/026 project achieved to improve rural capacity to manage income-generation activities based on mangrove-land. A total of 1150 villagers were trained in various aspects of agriculture, fisheries, forestry and home industries for income-generation, while income-generation group members received training in the operation of revolving funds. Ten township officials and 14 project villagers visited mangrove areas in Vietnam, Thailand and Malaysia to be exposed to various income-generation and mangrove conservation activities.

Forestry groups organized villagers in such activities as nursery raising, the creation of plantations and agroforestry species trials. Nursery raising and agroforestry created a wide impact as income-generation activities. Wood-saving stoves were popularized in the villages by women's groups. The project organized demonstrations and training for wood-saving stoves and supplied 2,000 stoves, thus creating a demand for improved stoves. About 3,000 fuel-wood saving stoves

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[1] ***Feasibility Study on Mangrove Reforestation,*** FO: DP/MYA/90/003, Terminal Report, Rome, FAO, 1994, pp.2-6 (Hereafter this work will be referred to as ***FO: DP/MYA/90/003, Terminal Report, Rome, FAO, 1994***)

[2] ***Forest Guidelines***, Yangon, FD, February, 2000, p.232

[3] ***FO: DP/MYA/90/003, Terminal Report, Rome, FAO, 1994***, p.4

[4] ***Community Development of Ayeyarwady Mangroves,*** FO: DP/MYA/93/026, Terminal Report, Rome, FAO, 2000, p.2 (Hereafter this work will be referred to as ***Community Development Ayeyarwady Mangroves.)***

[5] ***Forest Guidelines***, Yangon, FD, February, 2000, p.233

were distributed in Laputta and Bogalay Townships from March 1994 to October 1996. A training-cum-production centre was set up in a project village, at which 38 women were given tailoring training and supplied with sewing machines and 24 women were given weaving training and supplied with weaving looms for income generation.[1]

In addition, the project entitled "the Environmentally Sustainable Food Security and Micro-income Opportunities in the Ayeyarwady Delta" (MYA/96/008) was started in 1996. It provided the local people how to conserve the mangrove forests and to make the region self-sufficient in food as well as provided them the micro-income opportunities. The MYA/96/008 project was implemented in Laputta, Bogalay and Mawkyun Townships from 1996 to 1999.[2] The project focused on five main activities in environment and forest such as education and extension, community forestry, stove popularization, bank stabilization and village greening. UNDP and FAO contributed US dollar 30.6 million for the project. GOM provided kyat 16.82 million.[3]

The project's assistance has been directed towards more than 15,000 households of 252 poor villages in the three project Townships. About 12,555 fuel wood saving stoves were distributed in Laputta, Bogalay and Mawkyun Townships. The approach was built strong emphasis on building self-reliance of local communities for participatory development as well as on the range of provisions of alternative ways of making livelihood to the villagers so that they could earn continuous flows of income in the short run while they engage in longer task of Community Forestry development including conservation and protection of mangroves.[4]

Moreover, the project entitled "the Integrated Mangrove Rehabilitation and Management (IMRM) Project through Community Participation in the Ayeyarwady Delta" was undertaken by the Japan International Cooperation Agency (JICA) study team with close cooperation of the Myanmar counterpart personnel of the FD. The IMRM project was realized in 2 villages from Laputta and Bogalay Townships from 2002 to 2005. JICA contributed US dollar 2.5 million to the project. Mangrove-plantlets about 700,000 were planted in the target areas. In addition, the JICA continuously carried out the IMRM project in Laputta, Bogalay and Pyapon Townships, Ayeyarwady Delta from April 2007 to March 2013. The Japanese side provided ¥ 750 million and Myanmar also contributed 100 million Kyats to the project. The project purpose was the community and the mangrove forests co-exist in a sustainable manner in the selected areas where project activities were implemented within the Ayeyarwady Delta. Regarding its objective, mangrove forest coverage increased from 110,000 acres in 2007 to 116,200 acres in 2013 in the selected areas where project activities were implemented. The JICA also established about 1,401 acres of mangrove plantations as Action Research Plantation (ARP) in the Ayeyarwady Delta from 2008 to 2012. During the project period from 2007 to 2012, in cooperation with the FD, JICA supported about 1,523 acres of plantations and 680 acres of natural forest to 418 households from Bogalay, Laputta and Pyarpon Townships for the CF.[5]

The project entitled "Mangrove restoration Myanmar project" was implemented due to propose of Professor Dr. Nang Mya Han, Head of Myeik University (Marine Science) to the establishment of Mangrove Parks in Myanmar. This was followed up by Professor Dr Khin Maung

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[1] ***Community Development Ayeyarwady Mangroves,*** pp.7-11

[2] ***Environmentally Sustainable Food Security and Micro-Income opportunities in the Ayeyarwady Delta,*** FO: DP/96/008 Terminal Report, Rome, FAO, 2001, p.12 (Hereafter this work will be referred to as "***Environmentally Sustainable Food Security and Micro-Income opportunities in AD,*** FO: DP/96/008, 2001".)

[3] ***Forest Guidelines***, Yangon, FD, February, 2000, p.234

[4] ***Environmentally Sustainable Food Security and Micro-Income opportunities in AD,*** FO: DP/96/008, 2001, p.15

[5] Khin Maung Lwin, Field Project Manager, Assistant Director, Myaung Mya District, ***The Integrated Mangrove Rehabilitation and Management Project through Community Participation in the Ayeyarwady Delta***, JICA and Forest Department (FD), MOECF, the Republic of the Union of Myanmar, July 2012, p.3

Cho, Head of Marine Science Department of Pathein University. The MOECAF signed the Memorandum of Understanding (MOU) with the WIF due to part of a large-scale national plan to be developed as this first university climate park in Myanmar. The Mangrove restoration Myanmar project was in cooperation with the Worldview International Foundation, Pathein University, Myeik University, Forestry University and MOECAF. The Chief Minister of Ayeyarwady Region gave supported the project. The Letten Foundation from Norway contributed US dollar 1.3 million to the project. This project was the first mangrove park project in Myanmar. It started in July 2012. It was three years research project. This is based on needs to further develop capacities of coastal universities in dealing with urgent challenges in the conservation and restoration of mangroves, as well as other sustainable environmental issues.

During the research period (2012-2015), it is evaluated that Myanmar has potential to restore 1,235,000 acres lost mangrove forests (50 percent of its lost area since 1980), with capacity to mitigate up to 500 million tons CO_2. This is a considerable contribution to global climate efforts, in addition to effectively protecting standing forests of 247,000 acres with carbon sink of 1 billion tons (estimated tonnage by using data from the Intergovernmental Panel on Climate Change (IPCC) in 2011).

During the research period, capacity building of the universities has been one of the main tasks. The project has supported the establishment of computer labs and other development needs, as well as research grants to 47 students and academic staff. In addition to practical research in testing out various methods of mobilizing local communities as well as established a mangrove university park on 1,800 acres land, with the first mangrove gene bank of its kind (Photograph-1).

Photograph 1 *Pathein University Mangrove Park in Ayeyarwady Region*

Source: *Three years research project Mangrove restoration Myanmar July 2012-June 2015*, https://media-openideo-rwd.oiengine.com/attachments/dc012e47-203d-41cf-bd56-cf5e43e79c9c.pdf

Globally, there are at least 68 mangrove obligate species, with 65 in Myanmar representing one of the world's richest bio resources. It is therefore of great importance to protect and take care of this bio rich resources in Myanmar. Establishment of a mangrove gene bank as part of a comprehensive mangrove park concept, which is of importance for future protection and conservation. Therefore, it can generate substantial income from carbon climate markets and become an important source for future funding.[1]

The research project has provided to support for local initiatives of community development. Moreover, it included practical efforts to introduce fuel saving stoves and low-cost

[1] ***Three years research project Mangrove restoration Myanmar July 2012-June 2015***, https://media-openideo-rwd.oiengine.com/attachments/dc012e47-203d-41cf-bd56-cf5e43e79c9c.pdf

solar lamps.[1] The research project has provided solutions for community participation with increased income from creation of new livelihood initiatives. The project created that new livelihood by training of women in the use of mangrove bark natural colours for clothes, utilization of medicinal mangrove-based products, honey production in mangrove areas and orchid production in mangrove forests in 2015. Mobilizing coastal communities inspires valuable capacity not only in nursery establishment but also in restoration management. Concerning the test project, about 43 villagers in Kan Su, which was contributed greatly to the production of 36,000 mangrove seedlings as their own nurseries.[2] If no effective action is taken, the vital mangrove forest could be lost. It is therefore not only of national importance in restoration of mangrove forests in Myanmar, but also it is of equal importance in the global society.

In Rakhine State, regarding the collaboration with INGOs in mangrove conservation and rehabilitation sectors, the Mangrove Action Project (MAP) was commissioned by the Act for Change, Invest in Potential (ACTED's) Myanmar office. The MAP conducted two parts training on Community-Based Ecological Mangrove Restoration (CBEMR) in the city of Sittwe, Rakhine State. Firstly, the theory workshop training was carried out from 16th January 2017 to 20th January 2017. Secondly, the practical field training was undertaken from 23rd January to 29th January 2017. The CBEMR training's objective was full ecosystem restoration. The CBEMR training is an alternative mangrove restoration technique in which local communities were encouraged to facilitate the natural regeneration of mangroves by restoring and improving their local hydrology and topography. The Trainers were Dominic Wodehouse and Jim Enright from MAP. The number of forty-two participant-member from the governmental organizations, Non-Governmental Organizations (NGOs), Civil Society Organization (CSO) and Community Based Organization (CBO) jointed in this training. The impetus for training was the rapid loss of mangrove forest coverage in northern Rakhine State, with the need for mangrove rehabilitation linked to Disaster Risk Reduction (DRR) by re-establishing coastal green belts to buffer against tropical storms, reducing wave surge and wind damage, as well as slowing coastal erosion.[3]

The project villages were Ahmyintgyun (ANG), Nga Tauk Te (NTT) and Jiro Pasig (JP). ANG village is located 20 km from Sittwe which has 2,260 people from 456 households (HHs). All HHs collected or bought wood for fuel, at 21 pieces of 18″wood costing one dollar. To enable the return of mangrove resource, the conservation group had dissipated and needed to be re-built. So, the Community Empowerment and Resilience Association (CERA) worked developing a small, fenced off demonstration site, education the village about mangrove benefits, and replanting the wind-damaged plantation areas (stocking density plantation 9,262.5 acres) in this village. NTT village is situated 15 km from Sittwe that has approximately 1,400 people from 300 HHs. The villagers explained that each family buys approximately 100,000 kyats of fuel-wood per year and had been doing so far more than 20 years. None of them used improved-cook stoves. In this village, the existing mangroves were cut due to shrimp farm construction. In mid-2015, the CERA developed existing young mangrove plantations. NTT village has an active conservation group of 10 members, which claimed to be maintaining CERA's plantation fence. JP village has approximately 4,000 people from 340 HHs which is located only 4 km from Sittwe. To protect this village, MSN started Establishment of Community Nurseries and Plantations project in 2008. As

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[1] U Win Sein Naing, Chairman, Mangrove Service Network (MSN), Yangon, ***Interview by Author***, 22 February 2018 at his office

[2] One out of local people from Kan Su Village (Myo Gyi), Ayeyarwady Delta, ***Interview by Author***, 3 October 2018 at this area

[3] ***Community-Based Ecological Mangrove Restoration: Training Report, Demonstration Site Establishment and Maintenance Report,*** Yangon, Mangrove Service Network (MSN), 2017, pp.2-4 (Hereafter this work will be referred to as ***CBEMR, MAP Report***)

the supporting of this project, JP village did not move inside. The real challenge within the Sittwe area was the combination of a huge demand for fuel-wood and grazing animals inhibiting mangrove regeneration.[1]

Moreover, the project entitled "Climate Change Adaptation in Coastal Communities of Myanmar: Improved Management of Mangrove Forests" was started from 2018 by the FD of the Ministry of Natural Resources and Environmental Conservation (MONREC) in Yambye Township, Rakhine State, with support from Embassy of Denmark in Myanmar. The project will end in 2023. The project focused on strengthening resilience of coastal communities to adapt climate change through rehabilitation and sustainable management of mangrove forests, and access to more sustainable livelihood opportunities. To implement the project, Denmark government provided US dollar 5 million. In July 2018, in cooperation with towns-elders, humanitarian organizations, teachers and students, the FD planted some 1,200 mangrove saplings by the seed sowing method, grafting method and traditional reproduction method in Min Kyaung Extended Protected Public Forest, near the Min Kyaung Bridge, Yambye Township. The FD planted the Byuchayhdauk-male (*Rhizophora apiculata*), Byuchayhdauk-female (*Rhizophora mucronata*), Byuoaksaung (*Bruguiera gymnorhiza*) species, which thrive in the target area.[2]

Conclusion

The ecosystem of the mangrove forests is of great importance for marine creatures and environment. If the mangrove forests were destroyed, the ecosystems would be destroyed. In Myanmar, mangrove ecosystems deteriorated for many reasons. In the Ayeyarwady Delta, more paddy was cultivated in the RFs in response to the growing population. Agriculture has been the principal driver of mangrove degradation in the Delta. In Rakhine State, the number of shrimp ponds increased in the RFs. Therefore, there is an urgent need to develop a clear-cut land use policy. Mangrove forests play a vital role in the fight against climatic changes and extreme weather events such as Cyclone Nargis.

During the periods of the Revolutionary Council (RC 1962-1974), the Burma Socialist Programme Party (BSPP 1974-1988), the State Law and Order Restoration Council (SLORC 1988-1997) and the State Peace and Development Council (SPDC 1997-2011) governments, mangrove forests degraded due to the government policy of promoting self-sufficiency in food production, lack of systematic management of mangrove ecosystems, low capacity at the local level of government, lack of understanding on sustainability of mangroves, lack of research capacity on sustainability of mangroves, lack of alternative employment, dependence on natural resources extraction, inadequate funding for implementation of the task and lack of public awareness of environmental issues, insufficient number of the FD staff to manage mangrove conservation, and weakness in coordination with other relative departments. At that time, there was weakness in law enforcement to control illegal encroachment.

Regarding Myanmar Forest Policy, Forest Law and instructions, the 1992 Forest Law demonstrated a shift from the old concept of revenue generation and restriction to motivation and share of management responsibilities with people's participation. The 1992 Forest Law emphasized people participation in forest management and private sectors involvement in forestry sector development. Moreover, the 1992 Forest Law encouraged community participatory approach in managing the forest resources. With the support of the 1992 Forest Law, the CF was

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[1] ***CBEMR, MAP Report***, pp.9-12

[2] ***Climate Change Adaptation: Management Mangrove Forests, Myanmar***, Naypyidaw, Forest Department (FD), Ministry of Natural Resources and Environmental Conservation (MONREC), 2018, pp.13,27

launched in Myanmar in 1995. On the other hand, the 1992 Forest Law has weakness because of the following points. There was no effective enforcement of forest law at that time due to the political situation in Myanmar. The Gross Domestic Product (GDP) for the country was reinforced by the foreign income acquired from the export of paddy. The Forest Law was out-of-date in terms of usages and degrees. There was no coordination of relative departments in implementing laws. Therefore, it is necessary to coordinate with relative departments in amending the already-existed laws or implementing the laws.

Government policies on forests play an important role in the forest management for every country. The 1995 Myanmar Forest Policy takes into consideration the multiple functions and uses of the forest, as well as its potential for sustainable development. The 1995 Forest Policy formalized the commitment and intent of the government in ensuring sustainable development of forest resources, both for environmental and economic purposes. The 1995 Forest Policy has identified six imperatives in accordance with forestry principles adopted at the United Nations Conference on Environmental and Development (UNCED).

Concerning the CF, CFIs were a major breakthrough in the forestry sector. For Community Forestry Development, implementing organization needed to ensure the livelihood support and poverty reduction by adaptive management for equitable sharing of benefits. It is necessary to provide secure and long-term access or ownership rights. It is also require making every effort to minimize transaction costs for all partners together with capacity building through experimental learning.

In order to set up a successful CF programme, the local communities, the local NGOs/IGOs/INGOs and the government agencies and the village leader need to be involved. Moreover, these three actors must interact with one another. The village leader influences the participation of the local communities and the relationship between him and the government officer indirectly affects the level of their participation in tree planting and maintenance activities.

Regarding the two areas, in the past, the virgin areas of mangrove forest in the Ayeyarwady Delta were higher than that of the areas in the Rakhine State. However, the amount of degradation of the mangrove forests in the Ayeyarwady Delta is getting higher in the later period in comparison with Rakhine State. It is mainly because of its higher population growth that demanded more land utilization. Moreover, the Ayeyarwady mangroves were more degraded when the Cyclone Nargis struck in Myanmar in 2008.

According to the aims of the local NGOs and IGOs/INGOs projects, they protected the remaining resources, created awareness of the need to conserve mangroves and initiated numerous activities to enhance the socio-economic development of the project areas. By means of participatory approaches towards community development, eco-friendly income-generation opportunities were created. Moreover, trainings on mangrove nursery management, bank stabilization techniques, financial management and fuel-wood saving stoves were contributed to the local people. Local NGOs and IGOs/INGOs projects enhanced the living standard of the villagers enabling them to earn an income in the short-term while simultaneously engaging in the long-term conservation of mangroves. However, the weak points of NGOs/IGOs/INGOs are organizing local communities, conducting the talks on mangrove conservation to them and providing cash to them as an incentive to attend the talk. Therefore, they should observe the etiquette of the Myanmar society.

In comparison with NGOs and IGOs/INGOs, local NGOs undertook small-scale mangrove restoration projects. Their projects were relatively short-term and limited. However, they could

cooperate more with local communities in the target areas. On the other hand, IGOs/INGOs could provide more financial supports, effective technical aids, systematic training courses and long-term mangrove restoration projects.

Improved cooking stoves, alternative fuels and other wood saving strategies were imperative to reduce mangrove cut for fuel for local utilization and income source. This effort would mitigate the pressure on mangrove forests for livelihood substance. To raise awareness of the value of mangroves, environmental education is essential. Moreover, it needed more to invite local NGOs and IGOs/INGOs to collaborate in mangrove conservation. Patrolling, monitoring, and allocating of enough staff, enough funds and logistic supports were needed to conserve the mangroves. To be successful in mangrove conservation, all the mangrove rehabilitation partners have to understand both the individual species and the community ecology of the naturally occurring mangrove species at the site, paying particular attention to reproducing, distribution and successful seedling establishment, and to understand the normal hydrology.

IGOs and INGOs have already been technologies and experiences that Myanmar can draw on. This was why international cooperation was so important for formulating long-term strategies. The Myanmar government would like to appreciate International Organizations like UNDP, FAO, JICA, and ACTMANG for their technical and financial assistance in developing policies, strategy and master plan. Thus, Myanmar government needed to cooperate more in implementing these to achieve the targets.

The 2018 Forest Law has a broader outlook, covering the environment, economic and social aspects such as conservation of biodiversity, establishment of commercial forest plantations for sustainable production by both the State and Private sectors, and formation of Community Forestry for the local communities. The Forest Law mentioned not only the tasks of the CF in detail but also the grievances of those who carried out the tasks of the CF. Moreover, the Forest Law meted out the punishments adaptable to the modern time. Regarding the extraction of forest product from the forest owned by the CF, the Forest Law also mentioned that taxes shall not be paid for the personal use but taxes shall be paid for commercial use.

Regarding the Bill of the Forestry By-law, the already-drawn bill was discussed among the personnel concerned and advice was sought from them. The advice sought from the personnel concerned was collected and revised. And then the main points were culled from them and recorded systematically. The final Bill of the Forestry By-law was amended with the use of the suggestions acquired from the scholar dialogues. The final bill was ratified through the workshop on the National Level. In view of the above steps, it is found that the drawing of the Bill of the Forestry By-law was made with transparency.

Moreover, Myanmar arranged preparations through the forest conservation to connect the carbon trade market. Green Climate Fund was established under the programme of the United Nations Environment Programme (UNEP), the World Bank and other international organizations. Green Climate Fund provided benefits to the country which could conserve the forests to mitigate the effects of the climatic changes. Myanmar was included in the list of 34 member countries which have calculated carbon sequestration. Myanmar attempted to reach the target to store 90 million kg carbon by 2030 (it is learnt that each tree can absorb and store 15 kg per year). Government officials, local NGOs, IGOs/INGOs, local communities, and relative departments cooperated for sustainability of mangrove to mitigate the effects of climatic changes to obtain payment from the Reducing Emission From Deforestation and forest degradation in developing countries (REDD). As mangrove forests are a natural heritage of the country, the government conducted concerted-efforts for the benefits of both present and future generations.

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မြန်မာဘာသာစကားရှိနောက်လိုက်ပစ္စည်းများ

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ထက်ထက်စိန်ဝင်း[၁]

အစီရင်ခံစာအကျဉ်း

ဤကျမ်းတွင် နောက်လိုက်ပစ္စည်းများကို ဘာသာဗေဒရှုထောင့်မှ လေ့လာတင်ပြထားပါသည်။ နောက်လိုက်ပစ္စည်းများသည် ပစ္စည်းအမျိုးအစားထဲတွင် ပါဝင်သော်လည်း သဒ္ဒါတာဝန်မရှိသော၊ ပြောသူ၏ အလေးအနက်ပြုလိုမှုများ၊ သဘောထားအဓိပ္ပာယ်များကို ဖော်ပြနိုင်သော ပစ္စည်းများဖြစ်ကြောင်း လေ့လာ တင်ပြထားပါသည်။ သဒ္ဒါတာဝန်ရှိသော ပစ္စည်းများနှင့် နောက်လိုက်ပစ္စည်းတို့ ဝါကျတွင်းအသုံးပြုပုံ နေရာအရမတူပုံတို့ကို လေ့လာထားသည်။ ဝါကျ အဆင့်တွင် နောက်လိုက်ပစ္စည်းများသည် ဝါကျတစ်ခုနှင့် တစ်ခု အဓိပ္ပာယ် ချိတ်ဆက်နိုင်သည့်အပြင် လက်တွေ့အတ္ထဗေဒနယ်ပယ်တွင်ပါ လက်တွေ့ လောကအနက်များကို ဖော်ပြနိုင်သော ပစ္စည်းများဖြစ်ကြောင်း လေ့လာထားပါသည်။ ထို့ကြောင့် နောက်လိုက်ပစ္စည်းများကို လေ့လာခြင်းသည် မြန်မာဘာသာ စကားရှိသဒ္ဒါကို လေ့လာခြင်းဖြစ်ပြီး၊ မြန်မာဘာသာစကား၏ သွင်ပြင်လက္ခဏာများကို ဖော်ထုတ်ရာ၌ အထောက်အကူပြုနိုင်မည် ဖြစ်ပါသည်။

နိဒါန်း

ပါရဂူဘွဲ့အတွက် “မြန်မာဘာသာစကားရှိ နောက်လိုက်ပစ္စည်းများ” ဟူသော ခေါင်းစဉ်ဖြင့် ကျမ်းပြုစုတင်သွင်းခဲ့ပါသည်။ အစဉ်အလာလေ့လာမှုတွင်ရော ဘာသာဗေဒလေ့လာမှုတွင်ပါ နောက်လိုက် ပစ္စည်းများကို သီးသန့်လေ့လာထားသောကျမ်းများ၊ စာအုပ်စာတမ်းများမရှိသေးသောကြောင့် လည်းကောင်း၊ မြန်မာဘာသာ စကားတွင် ထင်ရှားသောလက္ခဏာတစ်ရပ်ဖြစ်သည့် နောက်လိုက် ပစ္စည်းများ၏ သဘောသဘာဝများကို လေ့လာဖော်ထုတ်လိုသောကြောင့် လည်းကောင်း ကျမ်းတစ်စောင်အနေဖြင့် ပြုစုရခြင်းဖြစ်ပါသည်။ ပါရဂူဘွဲ့အကြိုသင်တန်း တက်ရောက်စဉ်တွင် ဆရာကြီးဦးခင်အေး၏ ဘာသာဗေဒပို့ချတန်းတွင် နောက်လိုက်ပစ္စည်းများ အကြောင်းကို မိတ်ဆက်သဘော သင်ကြားခဲ့ရပါသည်။ နောက်လိုက်ပစ္စည်းများသည် သဒ္ဒါတာဝန်မရှိဘဲ ပြောသူ၏ သဘောထားများ၊ အလေးအနက် ပြုလိုမှုများကို ဖော်ပြနိုင်သော ပစ္စည်းများဖြစ်ကြောင်း လေ့လာသင်ယူခဲ့ရပါသည်။ ထိုစဉ်အချိန်ကတည်းက နောက်လိုက်ပစ္စည်းများကို စိတ်ဝင်စားခဲ့ပါသည်။ ပါရဂူအကြို သင်တန်းအတွက် စာတမ်းတစ်စောင်တင်သွင်း ဖတ်ကြားရာတွင် စိတ်ဝင်စားခဲ့သော နောက်လိုက်ပစ္စည်းများ အကြောင်းကို မိတ်ဆက်အနေဖြင့် တင်သွင်းဖတ်ကြားခဲ့ပါသည်။ ထို့အပြင် ပါရဂူဘွဲ့အတွက် သုတေသနပြုစုရာတွင်လည်း နောက်လိုက် ပစ္စည်းများကို ကျယ်ကျယ်ပြန့်ပြန့်သိလိုသောကြောင့် နောက်လိုက်ပစ္စည်းများ အကြောင်းကို ဆရာကြီး ဒေါက်တာသိန်းနိုင်၏ လမ်းညွှန်ကြီးကြပ်မှုနှင့်အတူ စတင်လေ့လာ ခဲ့ပါသည်။

မြန်မာဘာသာစကားရှိ ပစ္စည်းများအကြောင်းကို လေ့လာထားသော သုတေသနကျမ်းများတွင် သဒ္ဒါတာဝန်ရှိသော ပစ္စည်းများအကြောင်းကို လေ့လာထားသော ကျမ်းများကိုသာ တွေ့ရသည်။ သဒ္ဒါ တာဝန် မရှိသော ပြောသူ၏ အလေးအနက်ပြုလိုသော သဘောထားများကို ဖော်ပြနိုင်သော နောက်လိုက် ပစ္စည်းများ အကြောင်းကို လေ့လာထားသောကျမ်းများ မရှိပေ။ ပြောသူ၏ အလေးအနက်ပြုလိုသော သဘောထားများကို ဖော်ပြနိုင်သော နောက်လိုက်ပစ္စည်းများကို အစပိုင်းတွင် သတ်သတ်မှတ်မှတ် အမည်ပေး လေ့လာထားခြင်း မရှိသေးပါ။

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[၁] ဒေါက်တာ ၊ ကထိက၊ မြန်မာစာ၊ ရန်ကုန်ပညာရေးတက္ကသိုလ်

ဘာသာဗေဒပညာရှင် ဂျွန်အိုကယ်က အစပိုင်းတွင် “Postposition” ဟု အမည်ပေးထားပြီး၊ နောက်ပိုင်းတွင် Phrase Particles ဟု အမည်ပေးခဲ့သည်။ မောင်ခင်မင်(ဓနုဖြူ)က နောက်လိုက်ပစ္စည်းဟု အမည်ပေးခဲ့ပြီး၊ မြန်မာစကားအကြောင်း တစေ့ တစ်စောင်း(၂၀၁၆)နှင့် မြန်မာသဒ္ဒါသင်ကြားရေး(၂၀၁၉) ဟူသော စာအုပ်တို့တွင် နောက်လိုက်ပစ္စည်းများ အကြောင်းကို မိတ်ဆက်ဖော်ပြခဲ့ပါသည်။ ဘာသာဗေဒပညာရှင် ဒေါက်တာမင်းလတ်ကမူ နောက်လိုက်ပစ္စည်းများကို ‘‘Particles” ဟု အမည်ပေးထားပြန်ပါသည်။ ထို့ကြောင့် ထိုပစ္စည်းများကို မောင်ခင်မင်(ဓနုဖြူ)၏ အမည်ပေးချက်အရ “နောက်လိုက်ပစ္စည်းများ”ဟု အမည်ပေးကာ ထိုပစ္စည်း များ၏ သဘောသဘာဝများကို အသေးစိတ်လေ့လာဖော်ထုတ်ထားသော ကျမ်းတစ်စောင် ဖြစ်ပါသည်။ လေ့လာခဲ့သည့် ၄နှစ်တာ ကာလတစ်လျှောက်လုံး ဘာသာဗေဒ ရှုထောင့်က လေ့လာခဲ့သော်လည်း၊ နောက်လိုက် ပစ္စည်းများကို အသေးစိတ် လေ့လာရင်းဖြင့် ထိုပစ္စည်းများသည် လက်တွေ့ အတ္ထဗေဒနယ်ပယ်တွင်လည်း လက်တွေ့ အဓိပ္ပာယ်များကို ဖော်ပြနိုင်သောပစ္စည်းများ ဖြစ်ကြောင်း လေ့လာတွေ့ရှိခဲ့ရသည်။ ထို့ကြောင့် ကျမ်းတွင် အခန်း(၅) ခန်းခွဲ၍ လေ့လာထားရာ၌ အခန်း(၄)အထိ သည် နောက်လိုက်ပစ္စည်းများကို ဘာသာဗေဒ ရှုထောင့်မှ လေ့လာထားခြင်း ဖြစ်ပြီး၊ အခန်း-၅ သည် နောက်လိုက်ပစ္စည်းများကို လက်တွေ့ အတ္ထဗေဒရှုထောင့်မှ ပဏာမ လေ့လာထား ခြင်းဖြစ်ပါသည်။

၁။ သုတေသနလုပ်ငန်းရည်ရွယ်ချက်နှင့် ဦးတည်ချက်များ

နေ့စဉ်ပြောဆိုသုံးစွဲနေသော မြန်မာစကားတွင် နောက်လိုက်ပစ္စည်းများကို ထည့်လဲသုံး၍ ပြောသူ၏ သဘောထားများခံစားချက်များကို ဖော်ပြနိုင်သည်ကို တွေ့ရသည်။ မြန်မာဘာသာစကားတွင် သဒ္ဒါတာဝန်မရှိသော ပြောသူ၏သဘောထားအဓိပ္ပာယ်များကို ဖော်ပြနိုင်သော နောက်လိုက် ပစ္စည်းများ ရှိနေသည်ကို တွေ့ရသော်လည်း အကျယ်တဝင့် လေ့လာထားသော ကျမ်းတစ်စောင်မှ မရှိသေးသဖြင့် လည်းကောင်း၊ မြန်မာဘာသာစကား၏ သွင်ပြင်လက္ခဏာများကို လေ့လာဖော်ထုတ်လိုသောကြောင့်လည်းကောင်း လေ့လာရခြင်းဖြစ်ပါသည်။ ထိုသို့ လေ့လာရာ၌ ဝါကျတွင်းတွင် နောက်လိုက်ပစ္စည်းများ၏ နေရာနှင့် အသုံးပြုပုံများ၊ နောက်လိုက်ပစ္စည်းကို အသုံးပြုလိုက်ခြင်းကြောင့် သဘောထား အဓိပ္ပာယ်များကို မည်သို့ဖော်ပြနိုင်ပုံ၊ ဝါကျတစ်ခုနှင့်တစ်ခု၏ အဓိပ္ပာယ်များကို မည်သို့ချိတ်ဆက်နိုင် ပုံတို့ကို လေ့လာထားပါသည်။ နောက်ဆုံးတွင် ဘာသာဗေဒနယ်ပယ်ကို ကျော်လွန်၍ လက်တွေ့ လောကတွင် ပြောသူ၏ ထုတ်မပြောသောအနက်များကို နောက်လိုက်ပစ္စည်းများက မည်သို့ဖော်ပြ နိုင်သည် တို့ကို လေ့လာထားပါသည်။

၂။ တွေးဆချက်များ

အခန်း(၁)သည် ကျမ်းအတွက် အဆိုကြမ်း (သို့) တွေးဆချက်ဖြစ်သည်။ ဂျွန်အိုကယ်၏ အဆိုနှင့် မောင်ခင်မင်(ဓနုဖြူ)၏ အဆိုနှစ်ခုကို အခြေပြု၍ လေ့လာထားပါသည်။

ဂျွန်အိုကယ်က-

> “ဝါကျအတွင်းရှိစကားလုံးများအကြား ဆက်သွယ်မှုအပေါ် အကျိုး သက်ရောက်မှု မရှိသော နောက်ကနေရသည့် ပစ္စည်းများဖြစ်သည်။ နောက်လိုက်ပစ္စည်းများသည် စကားလုံးများ၊ ဝါကျများကို လေးနက်စေခြင်း (သို့)ဝါကျတစ်ခုနှင့်တစ်ခု ဆက်သွယ်မှုကို ပြခြင်း ဟူသော

> အလုပ်ကိုသာ လုပ်ဆောင်ပါသည်။ အမှီဝါကျခွဲပစ္စည်း များနှင့်မတူပေ။ နာမ်နောက်ဆက်၊ ကြိယာ နောက်ဆက်များမဟုတ် ကြပေ။” [၁]

ဟူ၍ ဖော်ပြထားသည်။

> မောင်ခင်မင်(ဓနုဖြူ)က-
>
> “နောက်လိုက်ပစ္စည်းများသည် ဝါကျ၏ အရင်းခံအဓိပ္ပာယ်ကို မပြောင်းလဲစေဘဲ ဝါကျ၏ အစိတ်အပိုင်းတစ်ခု (သို့မဟုတ်) ဝါကျ တစ်ခုလုံးကိုပို၍ လေးနက်စေခြင်း၊ ဝါကျတစ်ခုနှင့် တစ်ခု၏ ဆက်သွယ်မှုကို ဖော်ပြခြင်းတို့ကို လုပ်ဆောင်သည်။ အလေး အနက်ပြုရာတွင် ရေးသူ၏ သဘောထား ထင်ဟပ်ခြင်းမျိုးလည်း ရှိတတ်သည်။ များသောအားဖြင့် နောက်ဆက်ပစ္စည်း များပါပြီးသား ဝါကျများ၏နောက်တွင် နောက်လိုက်ပစ္စည်းများ ထပ်လိုက်လေ့ရှိ သည်။”[၂]

ဟု ဆိုထားသည်။ ထိုအဆိုနှစ်ခုအရ တွေးဆချက်(၃)ချက်ရလာပါသည်။ တွေးဆချက်(၁)သည် နောက်လိုက် ပစ္စည်းများသည် နောက်ဆက်ပစ္စည်းများ၏ နောက်ကနေလေ့ရှိခြင်း၊ တွေးဆချက် (၂)သည် ဝါကျတွင်းတွင် နောက်လိုက်ပစ္စည်းများ ပါသည်ဖြစ်စေ မပါသည်ဖြစ်စေ ဝါကျ၏အရင်းခံအဓိပ္ပာယ် မပြောင်းလဲဘဲ နောက်လိုက် ပစ္စည်းများကို အသုံးပြုခြင်းကြောင့် အလေးအနက်ပြုလိုမှုများ၊ သဘောထားများ ပေါ်လွင်လာခြင်း၊ တွေးဆ ချက်(၃)သည် နောက်လိုက်ပစ္စည်းများသည် ဝါကျတစ်ခုနှင့် တစ်ခု၏ အဓိပ္ပာယ်ဆက်သွယ်မှုကိုဖော်ပြနိုင်ခြင်း ဟူသည့် တွေးဆချက်(၃)ခုအပေါ်တွင် အခြေခံ၍ လေ့လာခဲ့ပါသည်။ ထို့ကြောင့် အခန်း(၁)သည် ကျမ်းအတွက် တွေးဆချက်ဖြစ်သည်။ တွေးဆချက် တစ်ချက်ချင်းကို အခြေခံ၍ အခန်းတစ်ခန်းစီခွဲကာလေ့လာခဲ့ပါသည်။

တွေးဆချက်(၁)ကိုအခြေခံ၍ အခန်း(၂)တွင် နောက်လိုက်ပစ္စည်းများ၏ နေရာနှင့် အသုံးပြု ပုံများကို လေ့လာထားပါသည်။ တွေးဆချက်(၂)ကို အခြေခံ၍ အခန်း(၃)တွင် နောက်လိုက်ပစ္စည်းများ၏ အလေးအနက် ပြုလိုမှုများ၊ သဘောထားများကို လေ့လာထား ပါသည်။ တွေးဆချက်(၃)ကို အခြေခံ၍ အခန်း(၄)တွင် ဝါကျတစ်ခု နှင့်တစ်ခု၏ အဓိပ္ပာယ် ဆက်သွယ်ပုံများကို လေ့လာထားပါသည်။ ထိုသို့လေ့လာရင်းဖြင့် နောက်လိုက် ပစ္စည်းများသည် အထွေထွေဘာသာဗေဒနယ်ပယ်ကို ကျော်လွန်၍ လက်တွေ့လောကတွင် လက်တွေ့ အဓိပ္ပာယ် များကို ဖော်ပြနိုင်ကြောင်းတွေ့ရှိရသဖြင့် အခန်း(၅)တွင် နောက်လိုက်ပစ္စည်းများကို လက်တွေ့အတ္ထဗေဒရှုထောင့်မှ နေ၍ ပဏာမလေ့လာထားခြင်းဖြစ်ပါသည်။

၃။ လုပ်ဆောင်ချက်များနှင့် စိစစ်ချက်များ

သုတေသနကာလ(၄)နှစ်အတွင်း စာတမ်း(၄)စောင် ဖတ်ကြားတင်သွင်းခဲ့ပါသည်။ ပထမနှစ်တွင် “နောက်လိုက် ပစ္စည်းများ၏ သဘောသဘာဝများ”၊ ဒုတိယနှစ်တွင် “နောက်လိုက်ပစ္စည်း များ၏ နေရာ”၊ တတိယနှစ်တွင် “နောက်လိုက်ပစ္စည်းများ၏ အလေးအနက်ပြုမှုများ”၊ စတုတ္ထနှစ်တွင် “နောက်လိုက်ပစ္စည်းများ၏ အလေးအနက်ပြုထူးခြားမှုများ”ဟူ၍ ဖတ်ကြား နိုင်ခဲ့ပါသည်။ ထိုစာတမ်းများကို ဆရာကြီးဆရာမကြီးများ၏ ဝိုင်းဝန်းဆွေးနွေး အကြံပြုချက် များဖြင့် လိုအပ်သည် များကို ဖြည့်သွင်းပြီး ကျမ်းတစ်စောင်အဖြစ်ပြုစုခဲ့ပါသည်။

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[၁] Okell, John, 1969, 196.

[၂] ခင်မင်၊ မောင် (ဓနုဖြူ)၊ ၂၀၁၆၊ ၁၆၅

အခန်း(၁)သည် နောက်လိုက်ပစ္စည်းများ၏ ယေဘုယျသဘောသဘာဝကို လေ့လာထားသော အခန်းဖြစ်သည်။ ဝါကျတွင်အသုံးပြုပုံနေရာအရ ပစ္စည်းများကို နာမ်နောက်ဆက်ပစ္စည်း၊ ကြိယာ နောက်ဆက်ပစ္စည်း၊ ဝါကျပစ္စည်း၊ အမှီဝါကျကဏ္ဍပစ္စည်း၊ အမှီဝါကျပစ္စည်း၊ နောက်လိုက်ပစ္စည်းဟူ၍ အမျိုးအစားများခွဲခြား နိုင်သည့် အပြင် ပစ္စည်းစကားလုံးတစ်လုံးတည်းက ဝါကျတွင်းအသုံးပြုပုံနှင့် နေရာအရ သဒ္ဒါတာဝန် အမျိုးမျိုး ပြောင်းလဲထမ်းဆောင်နိုင်ကြောင်း လေ့လာထားသည်။ ပစ္စည်းအမျိုးအစားများထဲမှ ပြောသူ၏သဘောထား၊ ခံစားမှု၊ အလေးအနက်ပြုလိုမှုများကို ဖော်ပြနိုင်သော ပစ္စည်းများကို နောက်လိုက်ပစ္စည်းဟု ပညာရှင်များက သတ်မှတ်ခေါ်ဝေါ်ပုံကို လေ့လာထားသည်။ ပညာရှင်များ၏ ဖွင့်ဆိုသတ်မှတ်ချက်များအရ နောက်လိုက် ပစ္စည်းများသည် နောက်ဆက် ပစ္စည်းများ၏ နောက်ကနေလေ့ရှိခြင်း၊ ဝါကျတွင် နောက်လိုက်ပစ္စည်းများပါသည် ဖြစ်စေ မပါသည်ဖြစ်စေ ဝါကျ၏ အဓိပ္ပာယ်ပြောင်းလဲမှုမရှိခြင်း၊ နောက်လိုက်ပစ္စည်းများကို အသုံးပြုခြင်းဖြင့် ပြောသူ၏ သဘောထားများ၊ ခံစားမှုများ၊ အလေးအနက်ပြုလိုမှုများ ပေါ်လွင်လာခြင်း၊ နောက်လိုက်ပစ္စည်းများသည် ဝါကျတစ်ခုနှင့် တစ်ခု၏အဓိပ္ပာယ်ကို မည်သို့ချိတ်ဆက်ပေးနိုင်ခြင်းစသည့် ယေဘုယျလက္ခဏာများကို သာဓက ဝါကျများနှင့် ချိန်ထိုးလေ့လာထားပြီး၊ နောက်ပိုင်းအခန်းများတွင် ထိုအချက်တစ်ချက်ချင်းစီအလိုက် အခန်းတစ်ခန်းစီခွဲ၍ အသေးစိတ်လေ့လာထားပါသည်။

အခန်း(၂)တွင် နောက်လိုက်ပစ္စည်းများသည် နောက်ဆက်ပစ္စည်းများ၏ နောက်က နေလေ့ ရှိခြင်းဟူသော အချက်အရ ဝါကျတွင်းရှိနောက်လိုက်ပစ္စည်းများ၏နေရာကို အသေးစိတ် လေ့လာထားပါသည်။ ဝါကျတွင်း နေရာအရ နောက်လိုက်ပစ္စည်းများကို ဝါကျအလယ်တွင် တွေ့ရသော နောက်လိုက်ပစ္စည်းနှင့် ဝါကျအဆုံးတွင် တွေ့ရသော နောက်လိုက်ပစ္စည်း ဟူ၍ ခွဲနိုင်ကြောင်းလေ့လာထားပြီး၊ ဗနောက်လိုက်ပစ္စည်းများကို ဝါကျအလယ်တွင် မည်သို့အသုံးပြုပုံ နှင့် ဝါကျအဆုံးတွင် မည်သို့အသုံးပြုပုံ တို့ကို လေ့လာထားပါသည်။

အခန်း(၃)တွင် နောက်လိုက်ပစ္စည်းများကို အသုံးပြုခြင်းကြောင့် ပြောသူ၏ သဘောထား၊ ခံစားမှု၊ အလေးအနက်ပြုလိုမှုများ ပေါ်လွင်လာခြင်းဟူသော အချက်အရ ပြောသူ၏သဘောထား၊ခံစားမှု၊ အလေးအနက်ပြုလိုမှုများကို နောက်လိုက်ပစ္စည်းများက မည်သို့ ဖော်ပြနိုင်ကြောင်း အသေးစိတ် လေ့လာထားပါသည်။ ဝါကျတစ်ခုတွင် နောက်လိုက်ပစ္စည်း စကားလုံးပြောင်းလဲသုံးစွဲပုံအရ သဘောထား အဓိပ္ပာယ်အမျိုးမျိုး ပြောင်းလဲပုံ နှင့် နောက်လိုက် ပစ္စည်းစကားလုံးတစ်လုံးတည်းကပင် နာမ်ပုဒ်နှင့် ကြိယာပုဒ်တို့တွင် အသုံးပြုပုံများ အရ သဘောထားအဓိပ္ပာယ်အမျိုးမျိုး ကွဲပြားသွားပုံတို့ကို လေ့လာထားပါသည်။

အခန်း(၄)တွင် နောက်လိုက်ပစ္စည်းများသည် ဝါကျတစ်ခုနှင့် တစ်ခုအဓိပ္ပာယ် ဆက်သွယ်မှုကို ဖော်ပြနိုင်ခြင်း ဟူသောအချက်အရ နောက်လိုက်ပစ္စည်းများက ဝါကျတစ်ခုနှင့် တစ်ခုမည်သို့အဓိပ္ပာယ် ဆက်သွယ်ပုံများကို လေ့လာထားသည်။

အခန်း(၅)တွင် နောက်လိုက်ပစ္စည်းများသည် လက်တွေ့အတ္ထဗေဒရှုထောင့်အရ လက်တွေ့ လောကတွင်ပါပြောသူပြောလိုသောသဘောထားအဓိပ္ပာယ်များကို ဖော်ပြနိုင်ပုံကို လေ့လာထားသည်။ အခြေအနေ အဆက်အစပ်တစ်ခုတွင် ပြောသူနှာသူတို့လက်တွေ့ပြောဆိုသော စကားခွန်းအရ နောက်လိုက် ပစ္စည်းများသည် သဘောထား အဓိပ္ပာယ်အမျိုးမျိုး ဖော်ဆောင် နိုင်ပုံကို ပဏာမလေ့လာထားပါသည်။

၄။ တွေ့ရှိချက်များနှင့် ဆွေးနွေးသုံးသပ်ချက်များ

မြန်မာဘာသာစကားရှိ ပစ္စည်းအမျိုးအစားများတွင် သဒ္ဒါတာဝန်ကိုဖော်ပြသော်လည်း ပစ္စည်းများရှိသကဲ့သို့ သဒ္ဒါတာဝန်မရှိသော ပြောသူ၏ခံစားမှု၊ အလေးအနက်ပြုလိုမှု၊ သဘောထား အဓိပ္ပာယ်များကို ဖော်ပြနိုင်သော ပစ္စည်းများရှိကြောင်းသိရှိရသည်။ ဝါကျတွင်းရှိပစ္စည်းများ၏ သုံးစွဲပုံနေရာအရ ဘာသာစကားများကို အမျိုးအစားခွဲနိုင်ကြောင်း လေ့လာတွေ့ရှိရသည်။ ဝါကျထဲရှိ သက်ဆိုင်ရာ နာမ်ပုဒ်များနှင့်အတူယှဉ်တွဲဖြစ်နိုင်သော ပစ္စည်းများ ကို ယှဉ်တွဲပစ္စည်း ဟုခေါ်ဆိုနိုင်သည်။ ယှဉ်တွဲပစ္စည်းကို ၂မျိုးခွဲခြားနိုင်ပြီး၊ သက်ဆိုင်ရာ နာမ်ပုဒ်၏ရှေ့တွင် ဖြစ်နိုင်သောပစ္စည်းကို ရှေ့သွားပစ္စည်းဟုခေါ်ပြီး၊ သက်ဆိုင်ရာနာမ်ပုဒ်၏နောက်တွင် ဖြစ်နိုင်သော ပစ္စည်းကို နောက်လိုက်ပစ္စည်းဟု သတ်မှတ်နိုင်သည်။ အင်္ဂလိပ်ဘာသာစကား၏ သဘော သဘာဝသည် သက်ဆိုင်ရာ နာမ်ပုဒ်၏ရှေ့တွင် ပစ္စည်းများ ဝင်ရောက်ဖြစ်နိုင်သောကြောင့် အင်္ဂလိပ်ဘာသာ စကားကို ရှေ့သွားပစ္စည်း ဘာသာစကားဟု ခေါ်ဆိုနိုင်ပြီး၊ မြန်မာ ဘာသာစကား၏ သဘောသဘာဝသည် သက်ဆိုင်ရာ နာမ်ပုဒ်၊ ကြိယာပုဒ်နှင့် ဝါကျ၏အဆုံးတို့တွင် ပစ္စည်းများဝင်ရောက်ဖြစ်နိုင်သောကြောင့် မြန်မာဘာသာစကားကို နောက်လိုက် ပစ္စည်း ဘာသာစကားဟု ခေါ်ဆိုနိုင်သည်။ ယှဉ်တွဲပစ္စည်းအမျိုးအစားတွင် ပါဝင်သော နောက်လိုက် ပစ္စည်းနှင့် အလေးအနက်ပြုသဘောထားများကို ဖော်ပြနိုင်သောနောက်လိုက်ပစ္စည်းတို့၏ သဘော သဘာဝမှာ မတူပေ။ အခေါ်အဝေါ်ဝေါဟာရတူသည်ကို ဘာသာပြန်ထားခြင်းဖြစ်သည်။ နောက်လိုက် ပစ္စည်းများသည် ဝါကျတွင်းရှိ နေရာအရ နောက်ဆက်ပစ္စည်းများ၏ နောက်ကနေလေ့ရှိခြင်း၊ ဝါကျထဲတွင် နောက်လိုက်ပစ္စည်းများပါသည် ဖြစ်စေ၊ မပါသည်ဖြစ်စေ ဝါကျ၏အရင်းခံအဓိပ္ပာယ် မပြောင်းလဲခြင်း၊ နောက်လိုက် ပစ္စည်းများကို အသုံးပြုခြင်းကြောင့် ပြောသူ၏ ခံစားမှုများ၊ အလေးအနက် ပြုလိုမှုများ၊ သဘောထားများ ပေါ်လွင်လာခြင်းစသည့် နောက်လိုက် ပစ္စည်းများ၏သဘောသဘာဝများကို တွေ့မြင်ရသည်။

ဝါကျတွင်းရှိ နောက်လိုက်ပစ္စည်းများ၏ နေရာနှင့် အသုံးပြုပုံကို လေ့လာရာတွင် နာမ်ပုဒ်နှင့် ကြိယာပုဒ်တို့တွင်းရှိ စကားလုံးအစီအစဉ်အရ နောက်လိုက်ပစ္စည်းများ၏နေရာကို သိရသည်။

နာမ်ပုဒ်တစ်ခုအတွင်းရှိ စကားလုံးများ၏ အစီအစဉ်ကိုလေ့လာကြည့်လျှင်-

နာမ်	**နာမ်နောက်ဆက်ပစ္စည်း**	**နောက်လိုက်ပစ္စည်း**
စျေး	ကို	တော့
ခရေပွင့်	လေး	ပဲ
Junction Square	ကို	လေ

အထက်ပါသာဓကများတွင် အခြေခံနာမ်ပုဒ်တစ်ခုခု- (နာမ် + နောက်ဆက်ပစ္စည်း + နောက်လိုက် ပစ္စည်း) ဟူသော အစီအစဉ်ကိုတွေ့ရသည်။ အချို့နေရာတွင် နောက်ဆက်ပစ္စည်းကိုမြှုပ်ပြီး နာမ်၏ နောက်တွင် နောက်လိုက်ပစ္စည်း တိုက်ရိုက်လိုက်၍ အသုံးပြုသည်ကို တွေ့ရှိရသည်။ ထို့ကြောင့် အခြေခံနာမ်ပုဒ်တစ်ခုတွင် နောက်လိုက်ပစ္စည်းများသည် စကားလုံးအစီအစဉ်အရ နောက်ဆက် ပစ္စည်းများ၏ နောက်ကသာနေလေ့ရှိသည်ကို တွေ့ရှိရသည်။

ကြိယာပုဒ်တစ်ခုအတွင်းရှိ စကားလုံးများ၏အစီအစဉ်ကို လေ့လာကြည့်လျှင်-

အငြင်းပြပစ္စည်း	ကြိယာ	ကြိယာထောက်ပစ္စည်း	နောက်ဆက်ပစ္စည်း	နောက်လိုက်ပစ္စည်း
မ	ငြင်း	တော့	ဘူး	နော်။
	စာဖတ်	Ø	Ø	လေ။
	ရ	Ø	တယ်	လေ။
	ကြည့်	ပေး	Ø	ပါ။

အထက်ပါသာဓကများတွင် အခြေခံကြိယာပုဒ်တစ်ခု၌- (အငြင်းပြပစ္စည်း[ɔ] + ကြိယာ+ ကြိယာထောက် + ကြိယာနောက်ဆက်ပစ္စည်း + နောက်လိုက်ပစ္စည်း) ဟူသော စကားလုံး အစီအစဉ်ကို တွေ့ရသည်။ အချို့နေရာများတွင် နောက်လိုက်ပစ္စည်းများသည် ကြိယာနောက်က တိုက်ရိုက် လိုက်သည်ကို တွေ့နိုင်သည်။ အချို့နေရာများတွင် ကြိယာထောက်မပါဘဲ (ကြိယာ+ ကြိယာ နောက်ဆက်ပစ္စည်း +နောက်လိုက်ပစ္စည်း) ဟု တွေ့နိုင်သည်။ အချို့နေရာများတွင် နောက်ဆက် ပစ္စည်းမပါဘဲ (ကြိယာ + ကြိယာထောက် + နောက်လိုက်ပစ္စည်း) ဟုတွေ့နိုင်သည်။ ထို့ကြောင့် ကြိယာပုဒ် တစ်ခုတွင် နောက်လိုက်ပစ္စည်းများသည် စကားလုံးအစီအစဉ်အရ ကြိယာနောက်ဆက် ပစ္စည်းများ၏ နောက်ကသာနေလေ့ရှိသည်ကို တွေ့ရှိရသည်။

ဝါကျတွင်းနေရာကိုလိုက်၍ ဝါကျအလယ်တွင် တွေ့ရသော နောက်လိုက်ပစ္စည်းများနှင့် ဝါကျ အဆုံးတွင် တွေ့ရသော နောက်လိုက်ပစ္စည်းများ ဟူ၍ခွဲခြားနိုင်သည်။ ဝါကျ အလယ်တွင်တွေ့ရသော နောက်လိုက် ပစ္စည်းများမှာ- “က၊ ကား၊ ကော၊ ကို၊ ချည်း၊ ချည်းပဲ၊ ချည်းသာ၊ တော့၊ တော့ဖြင့်၊ တောင်၊ တောင်မှ၊ ပါ၊ ပဲ၊ ပင်၊ ပင်လျှင်၊ ဖြင့်၊ မူ၊ မူကား၊ များ၊ မြဲ၊ မှ၊ မှဖြင့်၊ မှာ၊ မျှ၊ မျှသာ၊ ရော၊ လည်း၊ လျှင်၊ သာ၊ သာလျှင်” ဟူ၍ အလုံး(၃၀)တွေ့ရသည်။ ဝါကျအဆုံးတွင်တွေ့ရသော နောက်လိုက်ပစ္စည်းများ မှာ-]ကိုး၊ ဆို၊ တကား၊ တမှ်၊ တည်း၊ နော်၊ ပါ၊ ပေ၊ ပဲ၊ ပေါ့၊ ပင်၊ ရယ်၊ လေ၊ ဟာ} ဟူ၍(၁၄)လုံး တွေ့ရသည်။

ဝါကျအလယ်တွင်တွေ့ရသော နောက်လိုက်ပစ္စည်းများသည် ဝါကျအတွင်းရှိ နာမ်ပုဒ်၊ ကြိယာပုဒ်၊ အထူးပြုပုဒ်၊ အမှီဝါကျခွဲ၊ အညွှန်းစကားတို့၏နောက်တွင် အသုံးပြုနိုင်သည်ကို တွေ့ရသည်။ သာဓက အားဖြင့်-

ကျွန်တော်က လူတစ်ယောက်တည်းကိုသာ ဖိတ်သည်။(နာမ်ပုဒ်)
(စာ-၄၅၈၊ ၂၀၁၄၊ ဒဂုန်တာရာ)
ကမန်းကတန်းတော့သွားလိုက်တယ်။(ကြိယာအထူးပြုပုဒ်)
အိမ်အကြီးကြီးတော့မဟုတ်ဘူး။(နာမ်အထူးပြုပုဒ်)
ဒါလေးတော့ ယူသွားပေးပါ။(အညွှန်းစကား)
အိပ်လို့က မရဘူး။(အမှီဝါကျပစ္စည်း)

[ɔ] negative prefix

ကြိယာပုဒ်တွင် နောက်လိုက်ပစ္စည်းများသည် အမျိုးမျိုးဝင်ရောက်၍ အသုံးပြုနိုင်သည်။ ဧကဝဏ္ဏကြိယာတွင် အသုံးပြုပုံ၊ ဗဟုဝဏ္ဏကြိယာတွင် အသုံးပြုပုံ၊ ကြိယာနှင့်ကြိယာ ထောက်ကြားဝင်၍ အသုံးပြုပုံ၊ နာမ်ပေါင်းကြိယာတွင် အသုံးပြုပုံ၊ ကြိယာအထူးပြုနောက် တွင် အသုံးပြုပုံတို့ကိုသိရသည်။

ဧကဝဏ္ဏကြိယာပုဒ်တွင် ဧကဝဏ္ဏကြိယာကို ရှေ့သို့ပွားယူပြီး ပွားယူထားသော ကြိယာ နောက်တွင် နောက်လိုက်ပစ္စည်းထည့်သွင်း၍ အသုံးပြုနိုင်သည်ကို တွေ့ရသည်။ အငြင်းဝါကျ၊ အမေးဝါကျ တို့တွင်လည်း ထိုကဲ့သို့ပွားယူပြီး အသုံးပြုသည်ကို တွေ့ရသည်။

သာဓကအားဖြင့်-

ပြောသာ ပြောပါ။

မွေးမှ မမွေးတာ။(အငြင်းဝါကျ)

ဒီကအမကြိုက်မှ ကြိုက်ပါ့မလားမသိဘူး။(အမေးဝါကျ)

(စာ-၁၄၄၊၂၀၀၂၊တက္ကသိုလ်ဘုန်းနိုင်)

ဟူ၍ တွေ့ရသည်။

ဗဟုဝဏ္ဏကြိယာများတွင် နောက်လိုက်ပစ္စည်းများဝင်ရောက်ဖြစ်နိုင်သည့် ပုံစံများကို လေ့လာ ကြည့်သော အခါ နှစ်မျိုးတွေ့ရသည်။ ဗဟုဝဏ္ဏကြိယာတွင် ရှေ့ဝဏ္ဏကိုရှေ့ဆုံးသို့ ပွားယူပြီး ပွားယူထားသော ကြိယာနောက်တွင် နောက်လိုက်ပစ္စည်းထည့်သွင်း၍ အသုံးပြုနိုင် သည့်အပြင် ဗဟုဝဏ္ဏကြိယာ အတွဲလိုက်ကို ရှေ့ဆုံးသို့ပွားယူပြီး နောက်လိုက်ပစ္စည်း ထည့်သွင်း၍ အသုံးပြုသောပုံစံကိုလည်း တွေ့ရသည်။

ဗဟုဝဏ္ဏကြိယာတွင် ရှေ့ဝဏ္ဏကို ရှေ့ဆုံးသို့ပွားယူပြီး ပွားယူထားသော ကြိယာ စကားလုံး နောက်တွင် နောက်လိုက်ပစ္စည်းဝင်ရောက်အသုံးပြုပုံမှာ-

လိမ်တော့ လိမ်မာတယ်။

ဆင်းလည်း ဆင်းရဲတယ်။

ဗဟုဝဏ္ဏကြိယာပင်ဖြစ်သော်လည်း ဗဟုဝဏ္ဏကြိယာအတွဲလိုက်ကို ရှေ့ဆုံးသို့ပွားယူပြီး ပွားယူထားသော ကြိယာနောက်တွင် နောက်လိုက်ပစ္စည်းဝင်ရောက်၍အသုံးပြုပုံမှာ-

ယုံကြည်တာတော့ ယုံကြည်ရပါတယ်။

စဉ်းစားတာတော့ စဉ်းစားရမှာပေါ့။

ဟူ၍ တွေ့ရသည်။

“နေ၊ ကြည့်၊ ထား” ကြိယာထောက်များပါသော ကြိယာပုဒ်တွင် အဓိကကြိယာ၏ နောက်တွင် နောက်လိုက်ပစ္စည်းဝင်ရောက်၍ အသုံးပြုနိုင်သည်ကိုတွေ့ရသည်။

မေ့တောင် နေတယ်။(စာ-၂၁၂၊ ၂၀၁၇၊ ဒဂုန်တာရာ)

စဉ်းစားသာ ကြည့်တော့။

မှတ်တောင် ထားရဦးမယ်။

နာမ်ပေါင်းကြိယာများ၌ နာမ်နှင့်ကြိယာကြားတွင် နောက်လိုက်ပစ္စည်း ဝင်ရောက်ဖြစ် နိုင်သည်။

လက်လည်း ညောင်းလာပြီ။

ခေါင်းတောင် ကိုက်လာပြီ။

အထူးပြုနောက်တွင်အသုံးပြုပုံများကို လေ့လာကြည့်သောအခါ ကြိယာအထူးပြုနှင့် နာမ် အထူးပြုတို့ နောက်တွင် နောက်လိုက်ပစ္စည်းများ ဝင်ရောက်ဖြစ်နိုင်သည်ကို တွေ့ရသည်။

ကမန်းကတန်းတော့ သွားလိုက်တယ်။(ကြိယာအထူးပြု)

အိမ်အကြီးကြီးတော့ မဟုတ်ဘူး။(နာမ်အထူးပြု)

ဟူ၍ တွေ့ရသည်။ ထိုသို့နာမ်ပုဒ်တွင်အသုံးပြုပုံ၊ ကြိယာပုဒ်တွင်အသုံးပြုပုံများ၌ နောက်လိုက် ပစ္စည်းများ၏ ထူးခြားချက်များကို သိရသည်။ ကြိယာပုဒ်တွင် နောက်လိုက်ပစ္စည်း အသုံးပြုပုံများကို လေ့လာကြည့်သောအခါ ထူးခြားမှုများကိုတွေ့ရသည်။ လုံးချင်းကြိယာများ တွင် နောက်လိုက်ပစ္စည်း လိုက်လိုသော် ကြိယာစကားလုံးကို ရှေ့သို့ပွားယူပြီး ပွားယူထားသော ကြိယာစကားလုံး၏ နောက်တွင် နောက်လိုက်ပစ္စည်းလိုက်သောပုံစံကိုလည်း တွေ့ရသည်။

သာဓကအားဖြင့်

ဆွေတို့ဟာ ရှင်းမှုရှင်းရဲ့လား။(သံသယသဘောဖြင့်မေး)

(စာ-၃၁၀၊ ၂၀၁၄၊ ဒဂုန်တာရာ)

'မှ'သည် နောက်လိုက်ပစ္စည်းဖြစ်သည်။ ထိုဝါကျတွင် 'မှ'ကို ဖြုတ်ပြီးသုံးကြည့်သော်-

ဆွေတို့ဟာ ရှင်းရဲ့လား။

ဟုပြောသော်လည်း အဓိပ္ပာယ်မှာ မပြောင်းသွားပေ။ သို့သော် နောက်လိုက်ပစ္စည်း မပါတော့သော ကြောင့် သဘောထားများ၊ အလေးအနက်ပြုလိုမှုများ မပါတော့ကြောင်းတွေ့ရသည်။ လုံးချင်းကြိယာပုဒ်များတွင် အလေးအနက် ပြုပြောလိုသောအခါတွင် ကြိယာစကားလုံးကို ရှေ့သို့ပွားယူပြီး ပွားယူထားသော ကြိယာစကားလုံး ၏နောက်တွင် နောက်လိုက်ပစ္စည်းလိုက်ကာ သုံးသောပုံစံကို သိရှိရသည်။ နောက်လိုက်ပစ္စည်းစကားလုံးကို ဖြုတ်ကြည့်သော် ရှေ့ကပွားယူထားသော ကြိယာစကားလုံးကိုပါ ဖြုတ်ရသည်ကိုသိရှိရသည်။

လုံးတွဲကြိယာများတွင်လည်း နောက်လိုက်ပစ္စည်းလိုက်လိုသော် လုံးတွဲကြိယာ၏ ရှေ့စကားလုံး တစ်လုံးတည်းကိုသာ ရှေ့သို့ပွားယူပြီး ပွားယူထားသောကြိယာ စကားလုံး၏ နောက်တွင် နောက်လိုက် ပစ္စည်း လိုက်သောပုံစံနှင့် လုံးတွဲကြိယာတွင် လုံးတွဲကြိယာကို အတွဲလိုက်ထပ်ကြဲပြီး ထပ်ကြဲထားသော ကြိယာနောက်တွင် နောက်လိုက်ပစ္စည်း လိုက်သော ပုံစံ(၂)မျိုးကို တွေ့ရသည်။ သာဓကအားဖြင့်

သူ့ကို ယုံတော့ ယုံကြည်ရပါတယ်။(အလေးအနက်ပြု)

ထိုဝါကျတွင် နောက်လိုက်ပစ္စည်းကိုဖြုတ်ပြီး ပြောကြည့်သော်-

သူ့ကိုယုံကြည်ရပါတယ်။

ဟုပြောသော်လည်း အဓိပ္ပာယ်မှာ မပြောင်းသွားပေ။ လုံးတွဲကြိယာများတွင် အလေးအနက် ပြုပြော လိုသောအခါ ထိုကြိယာအတွဲလိုက်ကို ရှေ့သို့ပွားယူပြီး ကြိယာပစ္စည်း]တာ} ကိုထည့်၍ အသုံးပြုသော ပုံစံကို တွေ့ရသည်။

ယုံကြည်တာတော့ ယုံကြည်ရပါတယ်။

နောက်လိုက်ပစ္စည်းကို ဖြုတ်ပြီးသုံးကြည့်သော် ပွားယူထားသော ကြိယာစကားလုံးကိုပါ ဖြုတ် ရသည်။ သို့ရာတွင် နာမ်ပေါင်းကြိယာများတွင်မူ လုံးချင်းကြိယာများနှင့် လုံးတွဲကြိယာများ ကဲ့သို့ ပွားယူခြင်းမပြုဘဲ နာမ်နှင့်ကြိယာကို ခွဲထုတ်ပြီး နာမ်၏နောက်တွင် နောက်လိုက်ပစ္စည်း လိုက်ကာ အသုံးပြုသောပုံစံကိုတွေ့ရသည်။

နှင်းငွေက ခေါင်းသာညိတ်ပြသည်။

ဤသည်မှာ ကြိယာပုဒ်တွင်တွေ့ရသောနောက်လိုက်ပစ္စည်းများ၏ ထူးခြားမှုများဖြစ်သည်။

နာမ်ပုဒ်များတွင်နောက်လိုက်ပစ္စည်းများအသုံးပြုပုံကို လေ့လာရခြင်းဖြင့် အခြေခံနာမ်ပုဒ် တွင် (နာမ်+ နောက်ဆက်ပစ္စည်း+ နောက်လိုက်ပစ္စည်း) ဟူသော ဖွဲ့စည်းမှုပုံစံအပြင် နာမ်နှင့် နောက်လိုက် ပစ္စည်းတို့ တိုက်ရိုက်တွဲ၍ သုံးသော ဖွဲ့စည်းမှုပုံစံကိုလည်း သိရသည်။နာမ်နှင့် နောက်လိုက်ပစ္စည်းတို့ တိုက်ရိုက်သုံးသော ပုံစံတွင် အချို့နောက်လိုက်ပစ္စည်းများကို ဖြုတ်၍သုံး သော်မရသောကြောင့် နောက်ဆက်ပစ္စည်းများဟု ထင်နိုင်ဖွယ်ရှိသည်။ အလေးအနက်ပြုပြောလို သောအခါတွင် ကံပုဒ်ပြပစ္စည်း ‘ကို’ နေရာတွင် ကတ္တားပြပစ္စည်း ‘က ၊ မှ’ တို့ဝင် ရောက် ဖြစ်နိုင်ပြီး ထို ‘က ၊ မှ’ တို့သည်ကတ္တားပြ ပစ္စည်းတာဝန်ကို မထမ်းဆောင်ပဲ နောက်လိုက် ပစ္စည်းတာဝန်ကို ထမ်းဆောင်နေသည်။

သာဓကပြရလျှင်-

ဒီစာအုပ်က ဒေါက်တာအောင်မြင့်ဦး ရေးတာ။

ဟူသောဝါကျတွင်’က’ သည်နောက်လိုက်ပစ္စည်းဖြစ်သည်။ သို့သော်ဝါကျထဲတွင် ဖြုတ်မရပေ။

ဒီစာအုပ်က

ဟူသော နာမ်ပုဒ်သည် ပြုလုပ်ခြင်းကိုခံရသော ကံပုဒ်များ ဖြစ်နေသည်။ ထို့ကြောင့် ကံပုဒ်ပြပစ္စည်း ‘ကို’ ကိုဝါကျထဲတွင် ထည့်သုံးကြည့်သော်-

ဒီစာအုပ်ကို ဒေါက်တာအောင်မြင့်ဦးရေးတာ။

ဟူ၍ ပြောနိုင်သည်။

ထို့ပြင် အဓိပ္ပာယ်ပေါ်လွင်ပြီးသား ဝါကျတို့၌ အချို့သောပုဒ်များကိုမြှုပ်၍ အဓိက အလေးအနက် ပြုလိုသောပုဒ်နှင့် နောက်လိုက်ပစ္စည်းတို့ တိုက်ရိုက်လိုက်၍ အသုံးပြုသည်။ မြန်မာဘာသာစကားတွင် အရေးဘာသာစကားနှင့် အပြောဘာသာစကားဟူ၍ နှစ်မျိုးရှိရာ အရေးဘာသာစကားသည် သဒ္ဒါ စည်းကမ်း တင်းကျပ်မှုရှိသည်။ အပြောစကားသည် အရေးစကား လောက် သဒ္ဒါစည်းကမ်းတင်းကျပ်မှု မရှိပေ။ အပြောစကားတွင် အဓိပ္ပာယ်ပြည့်စုံနေလျှင် အချို့သောပုဒ်များကို မြှုပ်၍ပြောဆိုတတ်သည်။ သာဓကပြရလျှင်-

ဟေ့ ဖိုးစိန်၊ မင်း ဖိုးစိန်သာ ဆိုတယ်၊ ငါ့လိုဆိုတတ်ရဲ့လား။

(စာ-၆၈၊ ၂၀၀၆၊ တက္ကသိုလ်ဘုန်းနိုင်)

ဟူသောဝါကျတွင် ‘သာ’သည် နောက်လိုက်ပစ္စည်းဖြစ်သည်။ သို့သော် ဝါကျထဲတွင် ဖြုတ်၍ မရပေ။ သာဓကဝါကျတွင် မြုပ်နေသော ပုဒ်များကို ဖော်ကြည့်သော်

ဟေ့ ဖိုးစိန်၊ မင်း ဖိုးစိန် ဖြစ်တယ်လို့သာ ဆိုတယ်။ ငါ့လိုဆိုတတ်ရဲ့လား။

ဟူ၍ ပြောနိုင်သည်။ ‘ဖိုးစိန်’ ဟူသော နာမ်ပုဒ်နှင့် ‘သာ’ နောက်လိုက်ပစ္စည်းတို့ကြားတွင် မြုပ်နေသော ပုဒ်များမှာ ‘ဖြစ်တယ်’ဟူသော ကြိယာပုဒ်နှင့် ‘လို့’ဟူသော အဓိဝါကျခွဲပြပစ္စည်း တို့ဖြစ်ကြသည်။ ထို့ကြောင့် အလေးအနက်ပြုပြောလိုသောအခါတွင် အဓိကအလေးအနက် ပြုချင်သောပုဒ်နှင့် နောက်လိုက်ပစ္စည်းတို့ တိုက်ရိုက်တွဲပြီး သုံးသည်ကို တွေ့ရသည်။ ထိုအခါ မျိုးတွင် နောက်လိုက် ပစ္စည်းများကို ဖြုတ်သုံးမရဖြစ်နေသည်။ ဤသည်မှာ နာမ်ပုဒ်တွင် တွေ့ရသော နောက်လိုက် ပစ္စည်းများ၏ ထူးခြားချက်များ ဖြစ်သည်။

ဝါကျအဆုံးတွင်တွေ့ရသော နောက်လိုက်ပစ္စည်းများကို လေ့လာကြည့်သောအခါ နောက်လိုက် ပစ္စည်းများသည် ဝါကျ၏အဆုံးတွင်သာနေလေ့ရှိသည်။ မြန်မာဘာသာစကား၏ ဝါကျအဆုံးတွင် ဝါကျပစ္စည်း၊ နောက်လိုက်ပစ္စည်းနှင့် ဝါကျအဆုံးသတ်ဟန်ကွဲပစ္စည်းတို့ဖြင့် အဆုံးသတ်နိုင်သည်ကို တွေ့ရသည်။ ဝါကျအဆုံးတွင် တွေ့ရသော နောက်လိုက်ပစ္စည်းများသည် ဝါကျပစ္စည်းများ၊ ဝါကျ အဆုံးသတ်ဟန်ကွဲ ပစ္စည်းများနှင့်မတူပေ။ ဝါကျတွင် ဝါကျပစ္စည်းများကိုဖြုတ်၍မရပေ။ ဖြုတ်လိုက်လျှင် အဓိပ္ပာယ်ပြောင်းသွားသည်။ သို့သော် နောက်လိုက်ပစ္စည်း များကို ဝါကျတွင်ဖြုတ်၍လည်းရသည်။ မဖြုတ်ဘဲထည့်သွင်းအသုံးပြုသော်လည်း အဓိပ္ပာယ်မပြောင်းဘဲ အလေးအနက်ပြုလိုသော သဘောထားများ၊ အဓိပ္ပာယ်များပိုလာသည်။ ဝါကျအဆုံး သတ်ဟန်ကွဲ ပစ္စည်းများကမူ ဝါကျ၏ အဆုံးတွင်နေပြီး ပြောသူမှာ အမျိုးသမီး၊ အမျိုးသား၊ ကိုယ့်ထက် အသက်ငယ်ရွယ်သူ၊ ကြီးသူ စသည်ဖြင့် ဟန်ကွဲမှုအမျိုးမျိုးကို ဖော်ပြနိုင်သည်။

ဝါကျအဆုံးတွင်တွေ့ရသော နောက်လိုက်ပစ္စည်းများကို ဝါကျပစ္စည်းများနှင့် ရောထွေး တတ်ကြသည်ကို တွေ့ရသည်။ ဝါကျပစ္စည်းနှင့် နောက်လိုက်ပစ္စည်းတို့၏ သဘာဝမှာမတူပေ။ သာဓကအားဖြင့်- ‘စကားပြော ရအောင်။’ ဟူသော ဝါကျသည် ပြီးပြည့်စုံသောဝါကျ တစ်ခု ဖြစ်သည်။ ထိုဝါကျတွင် ‘ရအောင်’ သည် ဝါကျပစ္စည်း ဖြစ်သည်။ ထိုစကားလုံးကိုဖြုတ်၍ ‘စကားပြော’ ဟု သုံးလိုက်လျှင် အဓိပ္ပာယ်ပြောင်းသွားသည်။ ‘စကားပြော ရအောင်’ ဟုသုံးလျှင် အဓိပ္ပာယ်တစ်မျိုး၊ ‘စကားပြော’ ဟုသုံးလျှင် အဓိပ္ပာယ်တစ်မျိုး ဖြစ်သည်။ ထို့ကြောင့် ဝါကျတစ်ခုတွင် ဝါကျပစ္စည်းများကို ဖြုတ်၍မရပေ။ သို့ရာတွင် ထိုဝါကျများ၌ နောက်လိုက်ပစ္စည်း လိုက်၍ ရသည်ကို တွေ့ရသည်။

သာဓကအားဖြင့် -‘စကားပြောရအောင်။’ ဟူသောဝါကျတွင် ‘နော်’ ဟူသော နောက်လိုက် ပစ္စည်းထည့်၍ ‘စကားပြောရအောင်နော်။’ ဟုသုံးသော်လည်း အဓိပ္ပာယ်မှာ သိသိသာသာ မပြောင်းသွားပေ။ ထို့အပြင် ‘စကားပြော’ ဟူသော ဝါကျတွင်လည်း ‘နော်’ ဟူသော နောက်လိုက်ပစ္စည်း ထည့်၍ ‘စကားပြောနော်’ ဟုသုံးသော်လည်း အဓိပ္ပာယ်မှာ သိသိသာသာ မပြောင်းသွားပေ။ ထို့ကြောင့် ဝါကျပစ္စည်းနှင့် နောက်လိုက်ပစ္စည်းတို့၏ သဘာဝမှာ မတူပေ။

ထို့အပြင် ဝါကျအဆုံးသတ်ဟန်ကွဲပစ္စည်းများဖြစ်သည့် ‘ကွာ၊ ကွယ်၊ ဗျာ၊ ရှင်’ တို့ကိုထည့်သုံး ကြည့်သော်-

စကားပြောကွာ။

စကားပြောကွယ်။

စကားပြောဗျာ။

စကားပြောရှင်။ ဟုသုံးသော်ရသည်။

'စကားပြောကွာ။' ဟူသော သာဓကတွင် 'ကွာ' ကြောင့် ရွယ်တူ ယောကျ်ားလေးအချင်းချင်း ပြောသောဟန်မှာ ပေါ်လွင်နေသည်။ 'စကားပြောကွယ်။' ဟူသောသာဓကတွင် 'ကွယ်' ကြောင့် အသက်ကြီးသူကငယ်သူကို ပြောသော ဟန်မှာပေါ်လွင်နေသည်။ 'စကားပြောဗျာ။' ဟူသော သာဓကတွင် 'ဗျာ' ကြောင့် ယောကျ်ားလေး အချင်းချင်းရင်းနှီးသောဟန်မှာ ပေါ်လွင်နေသည်။ 'စကားပြောရှင်။' ဟူသော သာဓကတွင် 'ရှင်'ကြောင့် မိန်းကလေးက ပြောသောဟန်မှာ ပေါ်လွင်နေသည်။ ထိုသာဓကဝါကျများတွင် နောက်လိုက်ပစ္စည်းများကို ထည့်ကြည့်သော်-

စကားပြောပါကွာ။

စကားပြောလေကွယ်။

စကားပြောပေါ့ဗျာ။

စကားပြောပါရှင်။

ဟူ၍တွေ့နိုင်သည်။ နောက်လိုက်ပစ္စည်းများသည် ဝါကျအဆုံးသတ်ဟန်ကွဲပစ္စည်းများ၏ ရှေ့တွင် ဝင်ရောက်ဖြစ်နိုင်သည်ကို တွေ့ရသည်။ နောက်လိုက်ပစ္စည်းများကြောင့် အဓိပ္ပာယ်မှာ သိသိ သာသာပြောင်းမသွားပေ။

နောက်လိုက်ပစ္စည်းများသည်ဝါကျတွင်းရှိ အလေးအနက်ပြုလိုသော စကားလုံး၊ ပုဒ်၊ ဝါကျ တို့၏ နောက်ဆုံးတွင်နေ၍ အလေးအနက်ပြုခြင်း၊ သဘောထားအဓိပ္ပာယ်များကိုပေါ်လွင်စေခြင်း စသော တာဝန်များကို ထမ်းဆောင်နိုင်သည်။ တစ်ဦးနှင့်တစ်ဦးပြောဆိုဆက်ဆံရာတွင် ဝါကျဖွဲ့၍ ပြောဆိုရသည်။ ဝါကျတွင် အချက်အလက်သည် အရေးပါသည်ဆိုသော်လည်း ပြောသူ၏ အလေးအနက်ထားမှုများ၊ ခံစားချက်များ၊ သဘောထားများကို နောက်လိုက်ပစ္စည်းများက ဖော်ပြနိုင်သည်။ ထိုသို့လေ့လာရာတွင် ပြင်ပအဆက်အစပ်အရ လေ့လာထားခြင်းမဟုတ်ဘဲ ဝါကျရှေ့နောက် အဆက်အစပ်အရ လေ့လာ ထားသည်။ ဝါကျတွင်း၌နောက်လိုက်ပစ္စည်းကြောင့် ဝါကျ၏ အချက်အလက်မှာ ပြောင်းလဲသွားခြင်း မရှိပေ။ နောက်လိုက်ပစ္စည်းများသည် မိမိရှေ့တွင်ရှိသော ပုဒ်၊ဝါကျတို့ကို အလေးအနက်ပြုရင်းဖြင့် သဘောထားအမျိုးမျိုးကို ဖော်ပြနိုင်ကြောင်းတွေ့ရသည်။ နောက်လိုက်ပစ္စည်းများတွင် ကန့်သတ်ပိုင်းခြား ပြသောသဘောထားကို ဖော်ပြသောနောက်လိုက်ပစ္စည်းများနှင့် အပါအဝင်ဖြစ်ကြောင်း သဘောထားကို ဖော်ပြနိုင်သော နောက်လိုက်ပစ္စည်းများ ဟူ၍ ယေဘုယျအားဖြင့် ခွဲခြားနိုင်သည်။ ဝါကျအလယ်တွင် တွေ့ရ သောနောက်လိုက်ပစ္စည်းများတွင် နာမ်ပုဒ်၏နောက်တွင် အသုံးပြုပုံနှင့် ကြိယာပုဒ်တွင် အသုံး ပြုပုံတို့အရ နောက်လိုက်ပစ္စည်း စကားလုံးတစ်လုံးတည်းပင် ဖြစ်သော်လည်း ပြောသူပြောလိုသော သဘောထားအဓိပ္ပာယ်မှာ မတူကွဲပြားသွားသည်။ အချို့နောက်လိုက်ပစ္စည်းတို့သည် နာမ်ပုဒ်တွင် အသုံးပြုပုံချင်း တူသော်လည်း ဝါကျအမျိုးအစားမတူညီမှုပေါ်တွင် မူတည်၍ သဘောထား အဓိပ္ပာယ် ကွာခြားသွားသည်။ သဘောထားအမျိုးမျိုးကို ဖော်ပြနိုင်သော ဝါကျ အလယ်တွင်တွေ့ရသော နောက်လိုက်ပစ္စည်း စကားလုံး 'ကော၊ ကို၊ ချည်း၊ တောင်၊ ပါ၊ ပဲ၊ ပင်၊ ဖြင့်၊ များ၊ မှ၊ ရော၊ လည်း၊ သာ'ဟူ၍ (၁၃)လုံးကို လေ့လာတင်ပြထားသည်။ နာမ်ပုဒ်တွင် အသုံးပြုပုံနှင့် ကြိယာပုဒ်တွင် အသုံးပြုပုံတို့အရ သဘောထားအဓိပ္ပာယ်များ ကွာခြားသွားပုံကို 'သာ'တွင် တွေ့နိုင်သည်။

'သာ'ကို နာမ်ပုဒ်တွင်အသုံးပြုပုံနှင့် ကြိယာပုဒ်တွင်အသုံးပြုပုံတို့အရ ပြောလိုသော သဘောထား အဓိပ္ပာယ်တို့မှာ ကွာခြားသွားကြောင်းတွေ့ရသည်။ နာမ်ပုဒ်တွင်အသုံးပြုပုံမှာ-

ယခင်ကမူဤနေရာ၌ ဆိတ်ခြံသာ ရှိခဲ့သည်။
(စာ-၁၆၊ ၂၀၀၂၊ တက္ကသိုလ်ဘုန်းနိုင်)
တောင်စွန်းကလေးသာ ရေးရေးကလေးထွက်နေတယ်။
(စာ-၂၁၃၊ ၂၀၁၄၊ ဒဂုန်တာရာ)

အထက်ပါသာဓကဝါကျများတွင် 'သာ'သည် နာမ်ပုဒ်၏နောက်တွင်နေ၍ ကန့်သတ်ပိုင်းခြားပြသော သဘောထား ကို ဖော်ပြနိုင်သည်။

ကြိယာပုဒ်တွင် အသုံးပြုပုံကို လေ့လာကြည့်သောအခါ လုံးချင်းကြိယာပုဒ်များတွင် အသုံးပြုပုံနှင့် နာမ်ပေါင်းကြိယာပုဒ်တွင် အသုံးပြုပုံတို့အရ ပြောသူ၏သဘောထားအဓိပ္ပာယ်တို့ ကွာခြားသွားကြောင်း တွေ့ရသည်။

လုံးချင်းကြိယာပုဒ်တွင်အသုံးပြုပုံမှာ-

တိုးပွားထက်မစွမ်းတော့ ဒွေးဇံလှပြောသာပြော။ (စာ-၈၀၊၂၀၁၁၊ရန်ကုန်ဘဆွေ)
လာသာလာပါ။

အထက်ပါ သာဓကဝါကျများတွင် 'သာ'သည် ခွင့်ပြုသောသဘောထား၊ တိုက်တွန်းသောသဘော ထားများ ကိုဖော်ပြနိုင်သည်။

နာမ်ပေါင်းကြိယာတွင် အသုံးပြုပုံမှာ
နှင်းငွေက ခေါင်းသာ ညိတ်ပြသည်။
စာသာဖတ်နေသည်။

အထက်ပါသာဓကများတွင် 'သာ' သည် အပြုအမူဆောင်ရွက်မှုတစ်ခုကိုသာ ပြုမူဆောင်ရွက် လိုက်သည် ဟူသော သဘောထားကို ဖော်ပြနိုင်သည်။

နာမ်ပုဒ်တွင် အသုံးပြုပုံချင်းတူသော်လည်း ဝါကျအမျိုးအစားမတူညီမှုအပေါ်တွင် မူတည်၍ သဘောထား အဓိပ္ပာယ်ကွာခြားသွားပုံကို 'များ နှင့် ရော' တို့၌တွေ့နိုင်သည်။

'များ'ကို နာမ်ပုဒ်၏နောက်တွင် အသုံးပြုပုံမှာ-

မင်းကများ ပြောရသေးသလား။(စာ-၄၆၈၊ ၂၀၁၄၊ ဒဂုန်တာရာ)
သူကများ ရန်လာတွေ့နေတယ်။

ဟူသောသာဓကဝါကျများတွင် 'များ' နောက်လိုက်ပစ္စည်းသည် 'က' နောက်ဆက်ပစ္စည်း နောက်ကနေ၍ အထင်သေးသော နှိမ်သောသဘောထားများကို အလေးအနက်ပြုဖော်ပြနေ သည်ကိုတွေ့ရသည်။

ထို့ပြင် အမေးဝါကျရှိ နာမ်ပုဒ်နောက်တွင် အသုံးပြုပုံမှာ-

အားတယ်မဟုတ်လား။ အားသားပဲ။ ဘာမျှားတုန်းဗျ။

(စာ-၃၉၂၊ ၂၀၁၄ ဒဂုန်တာရာ)

ဖေဖေမျှား ဒီကိုလာသလားလို့။

ဟူသော ဝါကျများတွင် 'များ'သည် မရေရာမသေချာသည်ကို မေးမြန်းသောသဘောထားများကို ဖော်ပြနိုင်သည်ကိုတွေ့ရသည်။ ထို့ကြောင့် နာမ်ပုဒ်၏ နောက်တွင်အသုံးပြုသည်ဟု ဆိုသော်လည်း 'က'နောက်ဆက် ပစ္စည်းနောက်တွင် အသုံးပြုပုံနှင့် အမေးဝါကျရှိနာမ်ပုဒ် နောက်တွင် အသုံးပြုပုံတို့အရ သဘောထားအဓိပ္ပာယ်များကွာခြားသွားကြောင်းတွေ့ရသည်။

'ရော'ကို နာမ်ပုဒ်တွင်အသုံးပြုပုံမှာ-

လှလှရော့ဘယ်သွားလဲ။

အိမ်ပြန်ရောက်ရင်ရော့ ဘယ်သွားဦးမလဲ။

ဟူ၍တွေ့ရသည်။ အမေးဝါကျမဟုတ်ဘဲ နာမ်ပုဒ်၏နောက်တွင် 'ရော' နောက်လိုက်ပစ္စည်း လိုက်ရုံဖြင့် အခြေအနေစူးစမ်းသည့်သဘောထားအပြင် အမေးသဘောကိုပါ ဖော်ပြနိုင်ကြောင်း တွေ့ရသည်။ သာဓကအားဖြင့်-

အမေရော့

ဟိုစာအုပ်ရော့

ဟူ၍တွေ့နိုင်သည်။

သို့သော် နာမ်ပုဒ်တွင်ဖြစ်သော်လည်း အမေးဝါကျမဟုတ်သော ဝါကျတွင်]ရော}ကို အသုံးပြုကြည့်သော်-

ဒေါ်ဒေါ်ရော့ လိုက်ချင်တယ်တဲ့။

အမေတို့ကိုရော့ ခေါ်လိုက်ပါ။

သမီးကိုရော့ ပေးပေးပါ။

ဟူသောသာဓကဝါကျများတွင် 'ရော'သည် ထပ်လောင်းပါဝင်သည့်သဘောထားဖြင့် အလေးအနက်ပြု ဖော်ပြနိုင်သည်ကို တွေ့ရသည်။

ကြိယာပုဒ်တွင်အသုံးပြုပုံမှာ-

ပေးရော့ ပေးရဲ့လား။

မေးရော့ မေးရဲ့လား။

သိရော့ သိရဲ့လား။

ဟူ၍ ကြိယာပုဒ်တွင်ပါ အမေးဝါကျ၌ 'ရော'သည် အခြေအနေစူးစမ်းသည့် သဘောထားကို ဖော်ပြ နိုင်သည်ကို တွေ့ရသည်။

ဝါကျအဆုံးတွင်တွေ့ရသော နောက်လိုက်ပစ္စည်းများ တွင်လည်း ဝါကျ၏ အဆုံးတွင်နေ၍ ဝါကျတစ်ခုလုံး၏ သဘောထားအဓိပ္ပာယ်များကို ဖော်ပြနိုင်သည်။ဝါကျအဆုံးတွင် တွေ့ရသော နောက်လိုက်ပစ္စည်းစကားလုံး] ကိုး၊ ဆို၊ နော်၊ပါ၊ ပဲ၊ ပေါ့၊ လေ၊ ဟာ}ဟူ၍ (၈)လုံး တွေ့ရသည်။

ထို့ပြင် ဘာသာစကားကို ပြောဆိုသုံးစွဲရာတွင် နောက်လိုက်ပစ္စည်း စကားလုံး တစ်လုံးတည်း အပြင် နှစ်လုံးအထိတွဲစပ်၍ အသုံးပြုနိုင်သည်။ နှစ်လုံးတွဲသုံးသော နောက်လိုက် ပစ္စည်းများတွင် အလေးအနက်ပြုလိုသော သဘောထားအဓိပ္ပာယ်များသည် တစ်လုံးတည်းသုံး သောဝါကျထက်ပိုကြောင်း တွေ့ရှိရသည်။ နောက်လိုက် ပစ္စည်းများသည် ဝါကျထဲတွင်ပါသည် ဖြစ်စေ၊ မပါသည်ဖြစ်စေ ဝါကျ၏ အချက်အလက်မှာ ပြောင်းလဲသွားခြင်း မရှိဟူသောအချက် နှင့် ချိန်ထိုးလေ့လာကြည့်ချက်အရ တစ်လုံးသည်ဝါကျထဲတွင် ဖြုတ်သော်လည်းရသည်။ ထည့်သွင်းအသုံးပြုသော်လည်းရသည်။ သို့သော် ကျန်တစ်လုံးကမူ ဝါကျထဲတွင်ဖြုတ်သုံးသော် ရသော်လည်း၊ ထည့်သွင်းအသုံးပြုကြည့်သော် အသုံးမပြုသော ဝါကျဖြစ်နေသည်။ နှစ်လုံးတွဲ အသုံးပြုသောအခါတွင် နောက်လိုက်ပစ္စည်း စကားလုံး နှစ်လုံး၏ သဘောထားအဓိပ္ပာယ်နှစ်ခု သည် တစ်လုံးတည်းအသုံးပြုသော ဝါကျ၏ သဘောထား အဓိပ္ပာယ်များထက်ပိုကြောင်း သိရသည်။

သာဓကအားဖြင့်

အမလေး လေးနာရီတောင်မှခွဲနေပြီ။

ဟူသောဝါကျတွင် 'တောင်မှ' သည် နောက်လိုက်ပစ္စည်းဖြစ်သည်။]မှ}ကိုဖြုတ်၍

အမလေး လေးနာရီတောင် ခွဲနေပြီ။

ဟုသုံးသော်ရသည်။ သို့သော် အလေးအနက်ပြုလိုမှုအတိုင်းအတာသည် ၂လုံးတွဲသုံးသောအခါ ထက်လျော့သွား ကြောင်း တွေ့ရသည်။ 'တောင်'ကိုဖြုတ်၍ သုံးကြည့်သော်-

အမလေး လေးနာရီမှ ခွဲနေပြီ။

ဟုသုံးသော် ထိုဝါကျပုံစံမျိုးကို မပြောကြပေ။ နောက်လိုက်ပစ္စည်း၂လုံးတွဲ၍

အမလေး လေးနာရီတောင်မှ ခွဲနေပြီ။

ဟုသုံးသော် နောက်လိုက်ပစ္စည်းတစ်လုံးတည်းပါသောဝါကျထက် အလေးအနက်ပြုပြောလိုသော အဓိပ္ပာယ်မှာ ပိုသွားကြောင်းတွေ့ရသည်။

သာဓကအားဖြင့်-

ဖိနပ်စီးရင်တောင်မှ မလွတ်ဘူး။

စကားပြောရင်တောင်မှ သတိထားပြောနေကြရတယ်။

(စာ-၂၈၊ ၂၀၀၂၊ တက္ကသိုလ်ဘုန်းနိုင်)

သူ့လူအမေကြီးကိစ္စကိုတောင်မှ ငွေကြေးထုတ်ပြီး အကုန်အကျခံထား သေးတာပဲ။

(စာ-၇၆၊ ၂၀၀၂၊ တက္ကသိုလ်ဘုန်းနိုင်)

ဟူသောသာဓကဝါကျများတွင်တွေ့နိုင်သည်။

အဓိန့်ပေးဝါကျ၊ စေခိုင်းဝါကျတို့၏ နောက်တွင် နောက်လိုက်ပစ္စည်းများ ထည့်သွင်း အသုံးပြုသောအခါ မူလ သဘောထားထက် အနည်းငယ်လျော့သွားစေကြောင်း တွေ့ရှိရသည်။

အဓိန့်ပေးဝါကျတွင်သုံးပုံမှာ- မေးပေးစမ်း။

မေးပေးစမ်းပါ။

စေခိုင်းဝါကျတွင်သုံးပုံမှာ- ဒီကိုလာ

ဒီကိုလာပါ။ (ယဉ်ကျေးသောသဘော)

ဟူ၍ တွေ့နိုင်သည်။

နောက်လိုက်ပစ္စည်းများသည် ဝါကျတစ်ခုနှင့်တစ်ခု ဆက်သွယ်မှုကို ဖော်ပြနိုင်သည်ကို တွေ့ရသည်။ ရှေ့ဝါကျက နောက်ဝါကျ၏အဓိပ္ပာယ်ကို ချိတ်ဆက်ပုံ၊ နောက်ဝါကျက ရှေ့ဝါကျ၏ အဓိပ္ပာယ်ကို ချိတ်ဆက်ပုံ၊ ရှေ့ဝါကျနှင့် နောက်ဝါကျ၏ အဓိပ္ပာယ်တို့ အပြန်အလှန်ချိတ်ဆက်ပုံ တို့ကိုတွေ့ရသည်။ ထိုသို့ချိတ်ဆက်ရာတွင် နောက်လိုက်ပစ္စည်းများသည် အဓိကသော့ချက် ဖြစ်နေသည်ကို တွေ့ရသည်။ ထိုဝါကျများတွင် နောက်လိုက်ပစ္စည်းများကို ဖြုတ်သုံးကြည့်သော် အချက်အလက်ကို ဖော်ပြနိုင်ကြောင်းတွေ့ရှိရသည်။

သာဓကအားဖြင့် ဝါကျနှစ်ခုတွင် နောက်လိုက်ပစ္စည်းပါသော ရှေ့ဝါကျသည် နောက်လိုက် ပစ္စည်းမပါသော နောက်ဝါကျ၏ အဓိပ္ပာယ်နှင့် ချိတ်ဆက်နေသည်။

မနက်စာကျွေးတော့ ကျွေးပါရဲ့၊ ကျွန်တော်က အားနာနေတာနဲ့ မစားခဲ့ဘူး။

(စာ-၂၄၆၊ ၂၀၁၆၊ သိန်းဖေမြင့်)

ဟူသော ဝါကျတွင် 'တော့'သည် နောက်လိုက်ပစ္စည်းဖြစ်သည်။ ထိုဝါကျနှစ်ခုတွင် ရှေ့က ဝါကျကို ဖြုတ်ပြီးပြောကြည့်သော်-

ကျွန်တော်က အားနာနေတာနဲ့မစားခဲ့ဘူး။

ဟု ပြောသော် အချက်အလက်ပြည့်စုံနေသည်ကို တွေ့ရသည်။ နောက်ကဝါကျကို ဖြုတ်၍ပြော ကြည့်သော် –

မနက်စာ ကျွေးတော့ ကျွေးပါရဲ့။

ဟုပြောကြည့်သော် နောက်လိုက်ပစ္စည်း 'တော့'ကြောင့် နောက်ကလာမည့် အချက်အလက်ရှိ သေးသည်ကို သိရသည်။ ပြောလိုသော အချက်အလက်မှာ မပြီးဆုံးသေးကြောင်း ခန့်မှန်းနိုင် သည်။ ထိုဝါကျတွင် 'တော့' နောက်လိုက်ပစ္စည်းကိုဖြုတ်ကြည့်သော်-

မနက်စာ ကျွေးပါရဲ့။

ဟုပြောကြည့်သော် အဓိပ္ပာယ်ပြည့်စုံနေသည်ကို တွေ့ရသည်။ ထို့ကြောင့် နောက်လိုက်ပစ္စည်း စကားလုံးများသည် ဝါကျတစ်ခုနှင့် တစ်ခုချိတ်ဆက်ရာတွင် အရေးပါသည်ကိုတွေ့ရသည်။

ဝါကျနှစ်ခုတွင် နောက်လိုက်ပစ္စည်းပါသော နောက်ဝါကျသည် နောက်လိုက်ပစ္စည်းမပါသော ရှေ့ဝါကျ၏ အဓိပ္ပာယ်နှင့်ချိတ်ဆက်နေသည်။ သာဓကအားဖြင့်-

မိုးရွာနေတယ်၊ လေတော့မပါဘူး။

ဟူသော သာဓကဝါကျတွင် 'တော့' သည် နောက်လိုက်ပစ္စည်းဖြစ်သည်။ ထိုဝါကျနှစ်ခုတွင် နောက်က ဝါကျကို ဖြုတ်ပြီး ပြောကြည့်သော်-

မိုးရွာနေတယ်။

ဟုပြောသော် အချက်အလက်ပြည့်စုံနေသည်ကို တွေ့ရသည်။ ရှေ့ကဝါကျကို ဖြုတ်၍ပြောကြည့် သော်-

လေတော့မပါဘူး။

ဟုပြောကြည့်သော် နောက်လိုက်ပစ္စည်း 'တော့' ကြောင့် ရှေ့ကပြောခဲ့သည့် အချက်အလက်ရှိသေး သည်ကို ခန့်မှန်းနိုင်သည်။ အချက်အလက်မပြည့်စုံသေးသည်ကို သိနိုင်သည်။ ထိုဝါကျတွင် 'တော့' နောက်လိုက်ပစ္စည်းကို ဖြုတ်ကြည့်သော်-

လေမပါဘူး။

ဟုပြောသော် အဓိပ္ပာယ်ပြည့်စုံနေသည်ကို တွေ့ရသည်။

ရှေ့ဝါကျနှင့် နောက်ဝါကျ အပြိုင်ချိတ်ဆက်နေသော ဝါကျများကို လေ့လာကြည့်သောအခါ ဝါကျ(၂)ခုတွင် တစ်ခုကအဟုတ်ဝါကျဖြစ်လျှင်၊ နောက်ဝါကျတစ်ခုက အငြင်းဝါကျ ဖြစ်နေသည် ကိုတွေ့ရသည်။ သာဓကအားဖြင့်-

ဒေါ်ဒေါ်တို့ ဥက္ကဋ္ဌတော့ ပါတယ်။ အတွင်းရေးမှူး ခင်မျိုးချစ်တော့ မတွေ့ ပါလား။

(စာ-၂၆၃၊ ၂၀၁၆၊ သိန်းဖေမြင့်)

ဟူသောသာဓကဝါကျတွင် 'တော့'သည် နောက်လိုက်ပစ္စည်းဖြစ်သည်။ ထိုဝါကျများတွင် နောက်ဝါကျကို ဖြုတ်ပြီး ပြောကြည့်သော်-

ဒေါ်ဒေါ်တို့ ဥက္ကဋ္ဌတော့ ပါတယ်။

ဟုပြောကြည့်သော် 'တော့' နောက်လိုက်ပစ္စည်းကြောင့် ဆိုလိုချက်မှာ မပြည့်စုံသေးချေ။ အချက်အလက် ကျန်နေသေးသည်ကို တွေ့ရသည်။ ထို့အတူပင် ရှေ့ဝါကျကို ဖြုတ်ပြီး ပြော ကြည့်သော်-

အတွင်းရေးမှူး ခင်မျိုးချစ်___ မတွေ့ပါလား။

ဟုပြောကြည့်သော် 'တော့' နောက်လိုက်ပစ္စည်းကြောင့် အဓိပ္ပာယ်မပြည့်စုံသေးကြောင်း အတွေ့ခံရသည့် သူမှာ မည်သူဖြစ်ကြောင်း ကျန်နေသေးသည်ကို သိနိုင်သည်။ ထို့ကြောင့် 'တော့' နောက်လိုက် ပစ္စည်းသည် ဝါကျတစ်ခုနှင့် တစ်ခုကို အပြန်အလှန်ချိတ်ဆက် ပေးနိုင်ကြောင်းတွေ့ရသည်။ ထိုဝါကျများတွင် ပါနေသော နောက်လိုက်ပစ္စည်းကို ဖြုတ်ပြီးပြောကြည့်သော်-

ဒေါ်ဒေါ်တို့ ဥက္ကဋ္ဌပါတယ်၊ အတွင်းရေးမှူး ခင်မျိုးချစ်ကို မတွေ့ပါလား။

ဟုပြောနိုင်သည်။ ထိုဝါကျများကို တစ်ခုချင်းစီ ပြောကြည့်သော်-

ဒေါ်ဒေါ်တို့ ဥက္ကဋ္ဌပါတယ်။

အတွင်းရေးမှူး ခင်မျိုးချစ်ကို မတွေ့ပါလား။

ဟု ဝါကျတစ်ခုချင်းသုံးသော် အဓိပ္ပာယ်ပြည့်စုံနေသည်ကို တွေ့ရသည်။

ထို့ပြင် နောက်လိုက်ပစ္စည်းများသည် ဝါကျတွင်းအဆက်အစပ်ကို ကျော်လွန်၍ လက်တွေ့ လောကနှင့် ဆက်စပ်ပြီး ပြောသူဆိုလိုသောအနက်ကို နာသူကကောက်ယူနိုင်သည်။

သာဓကအားဖြင့်-

ဂေါ်ဖီပန်းပွင့် ငါးရာနဲ့ပဲယူ။

ဟူသော စကားခွန်းတွင် 'ပဲ' နောက်လိုက်ပစ္စည်းစကားလုံးကြောင့် တန်ရာတန်ကြေးထက်လျှော့ ပေါ့ပေး လိုက်သည် ဟူသော အနက်ပိုလာသည်ကိုတွေ့ရသည်။ ပြောသူကထုတ်မပြောသော်လည်း နာသူက နားလည်နိုင် သည်ကို တွေ့ရသည်။ ထို့ကြောင့် နောက်လိုက်ပစ္စည်းများကို လက်တွေ့ အတ္ထဗေဒနယ်ပယ်တွင် လက်တွေ့ အဓိပ္ပာယ်ပြ ပစ္စည်းများဟု ခေါ်ဝေါ်သည်။ ဘာသာဗေဒရှုထောင့်အရ နောက်လိုက်ပစ္စည်းများကို ဝါကျအလယ် တွင်တွေ့ရသော နောက်လိုက်ပစ္စည်းနှင့် ဝါကျအဆုံးတွင် တွေ့ရသော နောက်လိုက်ပစ္စည်းဟု ခွဲခြား၍ ရနိုင် သကဲ့သို့ လက်တွေ့အတ္ထဗေဒနယ်ပယ်တွင် လက်တွေ့အဓိပ္ပာယ်ပြပစ္စည်းများကို ပုဒ်ပစ္စည်းနှင့် ဝါကျပစ္စည်းဟူ၍ ခွဲခြားနိုင်သည်။ ပုဒ်ပစ္စည်းသည် ဝါကျအလယ်တွင် တွေ့ရသော နောက်လိုက်ပစ္စည်းဖြစ်ပြီး၊ ဝါကျခွဲပစ္စည်းသည် ဝါကျအဆုံးတွင် တွေ့ရသော နောက်လိုက် ပစ္စည်းဖြစ်သည်။ ထို့ပြင် အခြေအနေအဆက်အစပ်တစ်ခုပေါ်တွင် မူတည်၍နောက်လိုက်ပစ္စည်း စကားလုံးများ ပြောင်းလဲသုံးစွဲပုံအရ ပြောသူဆိုလိုသောအနက်၊ သဘောထား၊ ခံစားချက်တို့ အမျိုးမျိုးကွဲပြားနိုင်သည်မှာ 'ပဲ နှင့် တောင်' နောက်လိုက်ပစ္စည်းတို့တွင် အထင်အရှားတွေ့နိုင်သည်။ ဆန့်ကျင်ဘက် သဘောထား နှစ်ခုကို 'ပဲ' နှင့် 'တောင်' နောက်လိုက်ပစ္စည်း နှစ်ခုတို့က ခွဲခြားဖော်ပြနိုင်သည်ကို တွေ့ရသည်။ နယ်မှရန်ကုန်သို့အလည်လာ၍ ဟိုတယ်တစ်ခုတွင် တည်းခိုနေသောနောက်ခံအခြေအနေတွင်-

ပြောသူက- ဒီဟိုတယ်မှာ တစ်ညငါးသောင်းပဲပေးရတယ်။

ဟုပြောလျှင် ထိုစကားခွန်းတွင် 'ပဲ' ကြောင့် မျှော်လင့်ထားသည်ထက် နည်းသောပမာဏဖြစ်သည် ဟူသော သဘောထား အဓိပ္ပာယ်သက်ရောက်နေသည်။ တို့ထင်ထားတာထက် ဈေးသက်သာ လိုက်တာဟူသော စကားခွန်းများကို ပြောသူကထုတ်ပြောစရာမလိုပဲ နာသူကနားလည်နိုင်သည်။

သို့သော်

ပြောသူက- ဒီဟိုတယ်မှာ တစ်ညငါးသောင်းတောင်ပေးရတယ်။

ဟုပြောလျှင် ထိုစကားခွန်းတွင် 'တောင်' ကြောင့် မျှော်လင့်ထားသည်ထက်များသော ပမာဏဖြစ် သောကြောင့် အံ့သြရသည့် သဘောထားသက်ရောက်နေသည်။ တို့ထင်ထားတာထက်များလိုက်တာ ဟူသော စကားခွန်းများကို ပြောသူကထုတ်ပြောစရာမလိုပဲ နာသူကနားလည်နိုင်သည်။

ထို့အပြင် နောက်လိုက်ပစ္စည်းစကားလုံး တစ်လုံးတည်းကပင် အခြေအနေအဆက်အစပ် မတူညီမှုတို့အရ သဘောထား အဓိပ္ပာယ်အမျိုးမျိုး ကွဲပြားနိုင်ကြောင်းတွေ့ရှိရသည်မှာ

'သာ' ကိုအသုံးပြုပုံ၌

ထိုင်သာထိုင်ပါ။

ဟူသော စကားခွန်းတွင် နောက်ခံအခြေအနေမှာ ဧည့်သည်မိန်းကလေးကို ထိုင်ရန်ပြောသော်လည်း မိန်းကလေးမှာ ထိုင်ရန် အားနာနေသောအခြေအနေတွင် အိမ်ရှင်က-

ထိုင်သာထိုင်ပါ။

ဟုပြောသည်။ ထိုစကားခွန်းတွင် 'သာ' နောက်လိုက်ပစ္စည်းကြောင့် ခွင့်ပြုသည်ဟူသော သဘောထား အပြင် တစ်ဖက်သားကို အားနာမှုမရှိရအောင် လမ်းကြောင်းဖွင့်ပေးသော သဘောထားများရသည်။ ထိုသဘောထား အဓိပ္ပာယ်ကို နာသူကနားလည်နိုင်သည်။

ထို့အပြင် သတိပေးဆိုင်းပုဒ်တစ်ခုဖြစ်သော-

ကုမ္ပဏီပိုင်ယာဉ်များသာရပ်ရန်။

ဟူသောစကားခွန်းတွင် 'သာ' နောက်လိုက်ပစ္စည်းကြောင့် ထိုနေရာတွင် ကုမ္ပဏီပိုင်ယာဉ်များသာ ရပ်ရန်ခွင့်ပြုပြီး အခြားယာဉ်များရပ်ရန်ခွင့်မပြုဟူသော အဓိပ္ပာယ်ရသည်။ ထိုအဓိပ္ပာယ်ကို 'သာ'နောက်လိုက် ပစ္စည်းကြောင့် နာသူက နားလည်နိုင်သည်။

ထိုသို့တွေ့ရှိချက်များအရ နောက်လိုက်ပစ္စည်းများသည် ပုဒ်တစ်ခုတွင် နောက်ဆက် ပစ္စည်းများ၏ နောက်ကနေလေ့ရှိခြင်း၊ ဝါကျတစ်ခုတွင် ဝါကျပစ္စည်းများ၏ နောက်ကနေလေ့ရှိခြင်း၊ ဝါကျတွင်းတွင် နောက်လိုက် ပစ္စည်းများပါသည်ဖြစ်စေ၊ မပါသည်ဖြစ်စေ ဝါကျ၏ အချက်အလက် မပြောင်းလဲခြင်း၊ ဝါကျတွင် နောက်လိုက် ပစ္စည်းများကို အသုံးပြုခြင်းကြောင့် ပြောသူ၏ သဘောထားများ။ ခံစားချက်များ၊ အလေးအနက်ပြုလို မှုများကို ဖော်ပြနိုင်ခြင်း၊ နောက်လိုက်ပစ္စည်း စကားလုံးတစ်လုံးချင်းစီတွင် ပြောသူပြောလိုသော သဘောထား အဓိပ္ပာယ် တစ်မျိုးစီကို ဖော်ပြနိုင်ခြင်း၊ နောက်လိုက်ပစ္စည်းများသည် နာမ်ပုဒ်တွင်အသုံးပြုပုံနှင့် ကြိယာပုဒ်တွင် အသုံးပြု ပုံကွာခြားချက်တို့အရ သဘောထားအဓိပ္ပာယ်အမျိုးမျိုး ကွဲပြားစေနိုင် ခြင်း၊ နောက်လိုက်ပစ္စည်းများသည် ဝါကျတစ်ခုနှင့် တစ်ခု၏ အဓိပ္ပာယ်ဆက်သွယ်မှုကို ဖော်ပြနိုင်ခြင်းဟူသည့် လက္ခဏာရပ်များ ရှိနေသည့်ပစ္စည်းများ ဖြစ်ကြောင်း သုံးသပ်တင်ပြအပ် ပါသည်။ နောက်ဆုံးတွင် အထွေထွေဘာသာဗေဒရှုထောင့်အရ ဝါကျတွင် နောက်လိုက်ပစ္စည်း များပါမှုမပါမှုသည် ဝါကျ၏အချက်အလက်ကို မပြောင်းလဲစေ သော်လည်း လက်တွေ့လောက တွင်မူ နောက်လိုက်ပစ္စည်းများပါမှုမပါမှုသည် ပြောသူပြောလိုသော သဘောထား၊ ခံစားချက်၊ အဓိပ္ပာယ်များကို ကွာခြားပြောင်းလဲစေနိုင်ကြောင်း တင်ပြအပ်ပါသည်။ ထို့ကြောင့် မြန်မာ ဘာသာစကားတွင် ထိုသို့ထူးခြားသည့် လက္ခဏာများဖြင့် နောက်လိုက်ပစ္စည်းများ ရှိနေခြင်းသည် မြန်မာဘာသာစကား၏ သိမ်မွေ့မှုတစ်ရပ်ပင် ဖြစ်ပါသည်။

နိဂုံး

မြန်မာဘာသာစကားရှိ နောက်လိုက်ပစ္စည်းများသည် သဒ္ဒါတာဝန်မရှိသော ပြောသူ၏ အလေးအနက်ပြု လိုမှုများ၊ သဘောထားများ၊ ခံစားချက်များကို ဖော်ပြနိုင်သော ပစ္စည်းများ ဖြစ်သည်။ ဤကျမ်းတွင် အထွေထွေ ဘာသာဗေဒရှုထောင့်အရ နောက်လိုက်ပစ္စည်းများကို လေ့လာထားခြင်းဖြစ်ရာ၊ လက်တွေ့အတ္ထဗေဒရှုထောင့်မှ နေ၍ လေ့လာကြည့်လျှင် နောက်လိုက်ပစ္စည်းများသည် ပြောသူ၊နာသူ နောက်ခံအခြေအနေအဆက်အစပ်တို့အရ အဓိက ကျသော စကားလုံးများဖြစ်နေသည်ကို တွေ့ရသည်။ ဤကျမ်းတွင် လက်တွေ့အတ္ထဗေဒ ရှုထောင့်မှနေ၍ နောက်လိုက်ပစ္စည်းများကို မိတ်ဆက်သဘောသာ လေ့လာထားခြင်း ဖြစ်ပါသည်။ ဆက်လက်၍ အသေးစိတ် လေ့လာ လိုပါက ကျမ်းတစ်စောင်တစ်ဖွဲ့ထိ လေ့လာနိုင်ပါကြောင်း တင်ပြအပ်ပါသည်။

ကျမ်းကိုးစာရင်း

မြန်မာဘာသာ

ကိုလေး၊ မောင်။ (၂၀၀၃)။ မြန်မာသဒ္ဒါ။ ရန်ကုန်တက္ကသိုလ် မြန်မာစာပါရဂူဘွဲ့အတွက် တင်သွင်းသောကျမ်း။

ခင်မင်၊ မောင် (ဓနုဖြူ)။ (၂၀၀၄)။ အတ္ထဗေဒနိဒါန်း။ ရန်ကုန်၊ ပညာတန်ဆောင်ပုံနှိပ်တိုက်။

ခင်မင်၊ မောင် (ဓနုဖြူ)။ (၂၀၁၁)။ လူငယ်များအတွက်စကားအကြောင်းစာအကြောင်း။ ရန်ကုန်၊ ကောင်းသန့်စာပေ။

ခင်မင်၊ မောင် (ဓနုဖြူ)။ (၂၀၁၃)။ ဘာသာစာပေအသွေးအရောင်အဆင်အကွက်။ ရန်ကုန်၊ ရာပြည့်စာအုပ်တိုက်။

ခင်မင်၊ မောင် (ဓနုဖြူ)။ (၂၀၁၄)။ ဘာသာအမြင်စာပေအမြင် (ဒု-ကြိမ်)။ ရန်ကုန်၊ စိတ်ကူးချိုချို ပုံနှိပ်တိုက်။

ခင်မင်၊ မောင် (ဓနုဖြူ)။ (၂၀၁၆)။ မြန်မာဘာသာစကားအကြောင်းတစေ့တစောင်း ။ ရန်ကုန်၊ လင်းလွန်းခင်စာပေ။

ခင်မင်၊ မောင် (ဓနုဖြူ)။ (၂၀၁၇)။ လက်တွေအတ္ထဗေဒနိဒါန်း (ဒု-ကြိမ်)။ ရန်ကုန်၊ the Key Collection

ခင်မင်၊ မောင် (ဓနုဖြူ)။ (၂၀၁၉)။ မြန်မာသဒ္ဒါသင်ကြားရေး။ မြန်မာနိုင်ငံဘာသာစကား ဦးစီးဌာန၊ ရန်ကုန်။

တာရာ၊ ဒဂုန်။ (၂၀၁၄)။ ဝတ္ထုတိုပေါင်းချုပ် (တ-ကြိမ်)။ ရန်ကုန်၊ the Key Collection

တာရာ၊ ဒဂုန်။ (၂၀၁၇)။ ဝတ္ထုလတ်ပေါင်းချုပ်။ ရန်ကုန်၊ စိတ်ကူးချိုချိုပုံနှိပ်တိုက်။

ထွန်းမြင့်၊ ဦး။ (၁၉၉၅)။ ဘာသာဗေဒ။ ရန်ကုန်၊ ရန်ကုန်တက္ကသိုလ်ဂျီအီးစီ (ပညာရေး) သမဝါယမလီမိတက်။

ပြည့်ပြည့်ဖြိုး၊ မ။ (၂၀၁၃)။ မြန်မာအပြောစကားရှိဝါကျအဆုံးသတ်ပစ္စည်းများ။ ရန်ကုန် တက္ကသိုလ် မြန်မာစာပါရဂူဘွဲ့အတွက် တင်သွင်းသောကျမ်း။

ဖေမောင်တင်၊ ဦး။ (၁၉၅၅)။ အလယ်တန်းမြန်မာသဒ္ဒါ ။ ရန်ကုန်၊ စာပေဗိမာန်ပုံနှိပ်တိုက်။

ဖေမောင်တင်၊ ဦး။ (၁၉၆၃)။ မြန်မာသဒ္ဒါနှင့်အသုံးအနှုန်း (တ-ကြိမ်)။ ရန်ကုန်၊ စာပေဗိမာန် ပုံနှိပ်တိုက်။

ဖေမောင်တင်၊ ဦး။ (၂၀၁၄)။ မြန်မာဝါကျဖွဲ့ထုံးကျမ်း ။ ရန်ကုန်၊ စိတ်ကူးချိုချိုပုံနှိပ်တိုက်။

ဖိုးစိန်၊ ဦး။ (ခုနှစ်မပါ)။ မြန်မာစာစီစာကုံးကျမ်း ပထမစာစောင် (သတ္တမအကြိမ်)။ ရန်ကုန်၊ တိုးစာပုံနှိပ်တိုက်။

ဖိုးစိန်၊ ဦး။ (ခုနှစ်မပါ)။ မြန်မာစာစီစာကုံးကျမ်း ဒုတိယစာစောင် (ပဉ္စမအကြိမ်)။ ရန်ကုန်၊ တိုးစာပုံနှိပ်တိုက်။

ဘဆွေ၊ ရန်ကုန်။ (၂၀၁၁)။ ဝတ္ထုတိုပေါင်းချုပ်။ ရန်ကုန်၊ စိတ်ကူးချိုချို ပုံနှိပ်တိုက်။

ဘုန်းနိုင်၊ တက္ကသိုလ်။ (၂၀၀၂)။ ဝသန်လေချိန်မှန်ကူး (ပဉ္စမအကြိမ်)။ ရန်ကုန်၊ ကံ့ကော် ဝတ်ရည်စာပေ။

ဘုန်းနိုင်၊ တက္ကသိုလ်။ (၂၀၀၆)။ ဤမြေမှသည် (ဒုတိယအကြိမ်)။ ရန်ကုန်၊ ကံ့ကော်ဝတ်ရည် စာပေ။

မြန်မာစာအဖွဲ့။ (၂၀၀၈)။ မြန်မာအဘိဓာန်။ ရန်ကုန်၊ နေလင်းပုံနှိပ်တိုက်။

မြန်မာစာအဖွဲ့။ (၂၀၁၃)။ မြန်မာသဒ္ဒါ။ ရန်ကုန်၊ တက္ကသိုလ်များပုံနှိပ်တိုက်။

သာထိုး၊ ဦး။ (၁၈၉၇)။ မြန်မာသဒ္ဒါသစ်။ရန်ကုန်၊ ဟံသာဝတီသတင်းစာတိုက်။

သာနိုး၊ မောင်။ (၂၀၀၉)။ မြန်မာစကားနှင့်စာပေ။ ရန်ကုန်၊ ကျောက်ဆောင်စာအုပ်တိုက်။

သာနိုး၊ မောင်။ (၂၀၁၀)။ ဘာသာဗေဒအခြေပြု။ ရန်ကုန်၊ ဒေါင်းစာပေ။

သောင်းလွင်၊ ဦး(ဘီ-အေ)။(၁၉၇၈)။ နည်းသစ်မြန်မာသဒ္ဒါ။ ရန်ကုန်၊ သာသနာရေးဦးစီးဌာန ပုံနှိပ်တိုက်။

သိန်းဖေမြင့်။ (၂၀၁၆)။ အရှေ့ကနေဝန်းထွက်သည့်ပမာ။ ရန်ကုန်၊ စာအုပ်စျေးစာအုပ်တိုက်။

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PREVENTIVE MEASURES FOR THE LANDSLIDES AND HILLSIDE DEVELOPMENT ALONG THE THAZI-TAUNGGYI CAR-ROAD BETWEEN YINMABIN AND KALAW

J-91 PREVENTIVE MEASURES FOR THE LANDSLIDES AND HILLSIDE DEVELOPMENT ALONG THE THAZI-TAUNGGYI CAR-ROAD BETWEEN YINMABIN AND KALAW

Aung Kyaw Myat[1]

Abstract

Geotechnical analysis along the road between Yinmabin and Kalaw, in Mandalay Region and Shan State was carried out aiming to gain preventive measure for the landslide due to the lack of consideration on landslide hazards and associated risk. The rocks comprise the sedimentary rocks of Plateau Limestone Group, Loi-an Group and Kalaw Red Bed, and the Yinmabin Metamorphics. Notably, four types of landslides such as rockfall, debris flow, creep and slump have been identified along this road. Rockfall is the commonest landslide mainly occurs along the manmade road cuttings generating potential threats to human life triggered by heavy and prolong rainstorm. Slope Mass Rating (SMR) values indicated that Yinmabin Meamorphics is the most vulnerable to landslide. Slope Mass Rating values are determined to assess the possible slope conditions such as Very Low Hazard Zone, Low Hazard Zone, Medium Hazard Zone and High Hazard Zone. Moreover, three landslide hazard zones are interpreted based on geological and geotechnical parameters. These zones are described as Landslide Hazard Zone I (west of Yinmabin), Zone II (eastern part of Yebokson and western part of Kyatsakan) and Zone III (the area between Nampandet and Wetphuye). Remedial measures have been proposed to mitigate the hazard.

Keywords: Geotechnical analysis, landslide, slope mass rating, landslide hazard zones

Introduction

Landslide is one of the most destructive geological hazards among the natural disasters that can cause the damage to loss of life, injuries, natural objects and man-made structures. This research is focused on the landslides along the Thazi-Taunggyi Car-road, between Yinmabin, Mandalay Region and Kalaw, Shan State (South). Preventive measures for the landslide hazards along the Thazi-Taunggyi Car-road had not been developed yet. The study area is mainly composed of sedimentary, metasedimentary and igneous rocks which include rock sequences of Yinmabin Metamorphics (Paleozoic), Lebyin Group (Carboniferous to Lower Permian), Plateau Limestone Group (Middle Permian to Middle Triassic), Loi-an Group (Jurassic), Pyinnyaung Formation (Upper Jurassic to Cretaceous), Kalaw Red Beds (Cretaceous), Older Alluvium (Pleistocene) and Alluvium (Holocene). The igneous rocks comprise granitic rocks, dioritic rocks, rhyolite and other igneous rocks of minor occurrence (Mesozoic) and granite gneisses (Upper Tertiary) as meta-igneous rocks. Metamorphic rocks are made up of calc-phyllite, sandy phyllite, and quartzite (Paleozoic) which are the product of regional metamorphism. The rock units are nearly north-south trending. Because of the differing behaviors of rock types, their strength and engineering properties also varied from place to place. Landslides are common along the car-road particularly during the rainy season, facilitated by hillside development resulting the great concern. The main purpose of this research is to create the landslide susceptibility map with respect to mitigation measures for each failure type who are engaged in development of the hillside area or the relevant responsible authorities or groups.

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Location and Accessibility

The research area lies between north latitudes, 20º 38' 00" to 20º 50' 00" and east longitudes, 96º 18' 00" to 96º 32' 00", and covering Universal Tranverse Mercator (UTM) map No. - 2096 - 05, 2096 - 06, 2096 - 09 and 2096 - 10. This area stretches to about 40 miles in east-west direction from Kywedatson-Yinmabin border (Mandalay Region) to Kalaw, (Shan State, South) which is part of the main road of Thazi-Taunggyi road, accessible whole year round as shown in Figure (1).

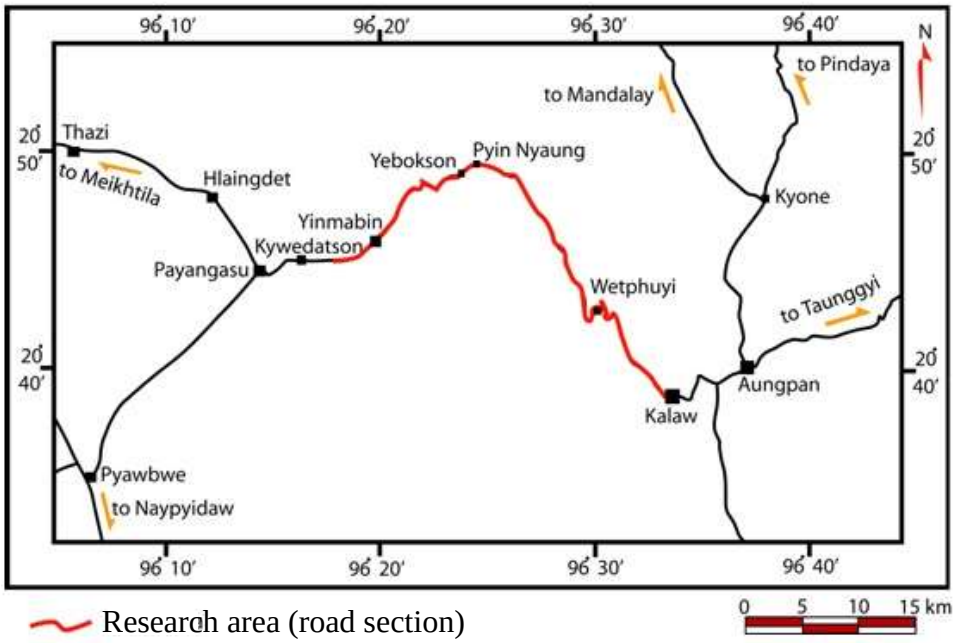

Figure 1 Location map of the research road section

Physiography

Physiographically, hills with steep slopes, rugged terrain and deep valleys are common phenomena. It also lies in the western part of the well known Shan Plateau.

With reference to the digital elevation model, the elevated hilly region occurs at the eastern and central part of the study area whereas the mountain ranges and valleys also confined to the western part as shown in Figure (2). The average elevation accounts to 900 meters above sea-level. According to the terrain image, the Pyinnyaung-Wetphuye area is highly rugged with steep slopes forming the most favourable site for triggering landslides. Besides, Yinmabin area is regarded as high in elevation to have a moderate relief with occasional steep slopes.

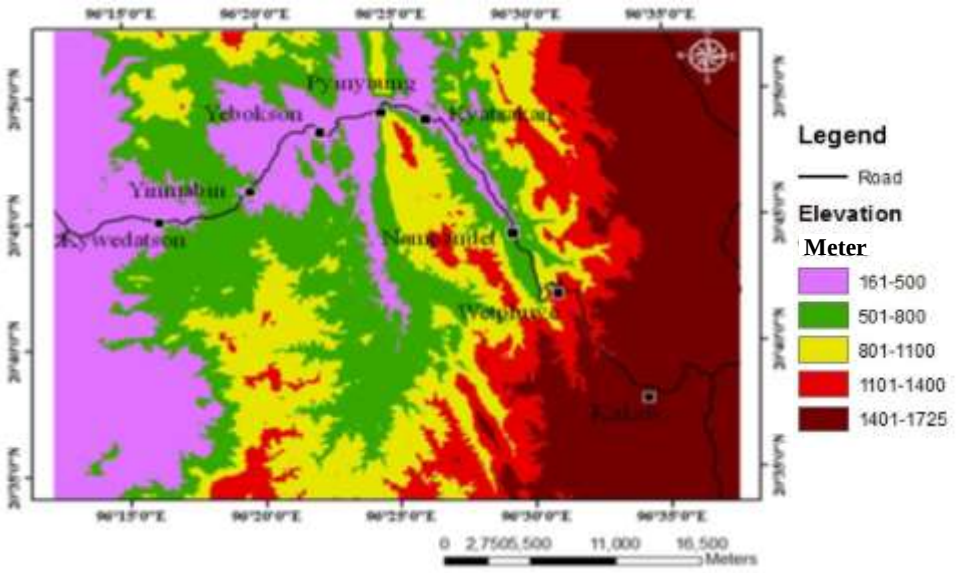

Figure 2 Physiographic map of the research area

Topographically, the research area can be divided into three kinds of topographic units;

(i) The flat-plain region (between 161 and 500 meters),

(ii) The hilly region with moderate heights (between 501 and 800 meters) and

(iii) The rugged region with steep slope (between 801 and 1725 meters).

Climate, Vegetation and Rainfall

Landslides are triggered by heavy rainfall throughout the season. The climatic condition of the study area is sub-tropical type. Part of the research area lies in the dry zone according to the Myanmar Information Management Unit (MIMU) map.

Dense reserve forests are covered 60 percent of the area and these include: hardwoods such as pyingado, padauk, timba and bamboo, etc. The residual soil covered in the sedimentary area at the eastern part is thick. Residual soil layer is considerable thin at the central and western part of the area.

Mostly, heavy rainfall condition occurs in August. Annual rainfall is 126 inches. Rainfall made the rock units to be highly weathered in nature that causes an increase in landslide effect. According the comparative study of rainfall data by using histogram, heavy rainfall occurs in May, June and September, in 2006-2008 and in May to October in 2011-2015 and also in September and October, in 2009 and 2010. The highest point is found in August in 2011 and September and October in 2011. Notably, landsides occurred in August of 2017 and 2018 which is shown in Figures (3) and (4).

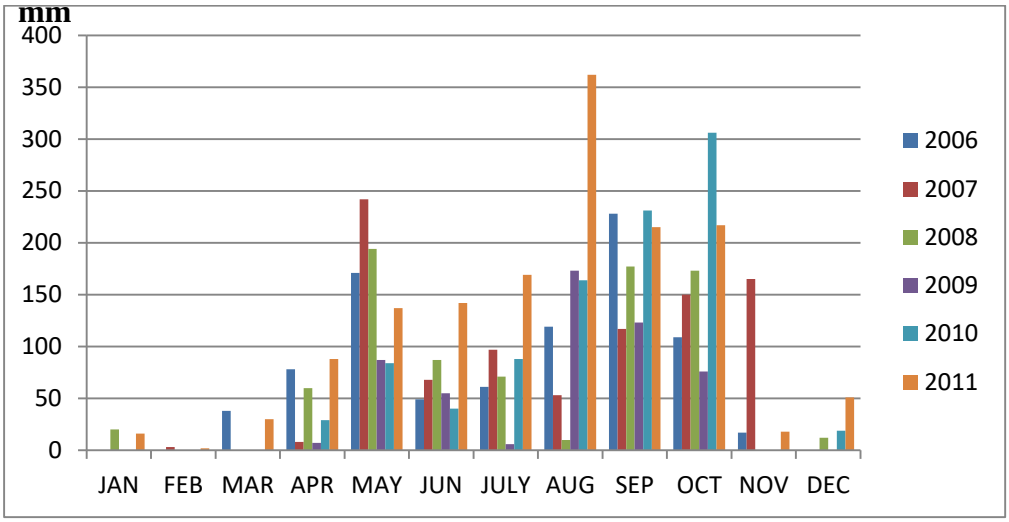

Figure 3 Histogram showing comparative study of the monthly rainfall data (2006-2011) (Data from Department of Meteorology and Hydrology)

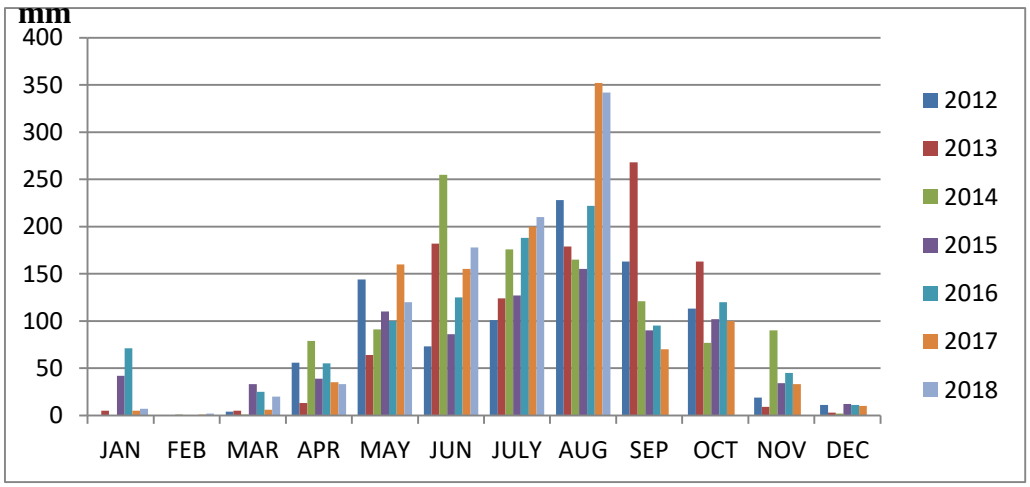

Figure 4 Histogram showing comparative study of the monthly rainfall data (2012-2018) (Data from Department of Meteorology and Hydrology)

Aims and Objectives

The main aim of this thesis is to gain preventive measure for the landslide due to the lack of consideration on landslide hazards and associated risk during construction period of this highway. The main objectives of the research are as follows;

(1) To study the influence of geological conditions on past and recent landslides of study area

(2) To understand the mechanism of landslides of the study area

(3) To collect the geological and structural data along the road

(4) To identify the landslide susceptibility in the manmade cuttings.

(5) To find the field evidences relating to landslides along the existing shear zone or fault zone (such as Shan Scarp Fault) and the tension joints

(6) To find out the controlling factors of landslide along the road.

(7) To analyse the discontinuities on slope faces

(8) To find the cause of slope failures in order to mitigate landslide

(9) To draw out the engineering geological map, landslide susceptible map and landslide hazard map of the study area

(10) To measure the landslide potential and demarcate the landslide zones

The study will focus on the theory and practice of landslide activities and their consequence hillside development. Because a numbers of tragic landslide occurred here in the rainy season annually, the impacts are by no means detrimental to human lives and properties. Thus, the research is proceeded for support of mitigation processes carried out to reduce and prevent the landslides in future.

Geological Investigation of the Study Area

Distribution of rock units

The geology of the research area is composed of the older granitoid plutons and Yinmabin Metamorphics which belong to Mogok Belt. The western part had been intruded by younger biotite microgranite with NNE-SSW trends. Metasedimentary units of Lebyin Group are exposed as rolling hills with dense vegetation and soil cover at the central portion. Plateau Limestone Group occupies the eastern part exposed along the Shan Scarp Fault Zone. Loi-an Group, Pyinnyaung Formation and Kalaw Red Bed at the easternmost part are exposed along the eastern part and their structural trend are NNW-SSE. Detailed geological map of the research area is shown in Figure (5).

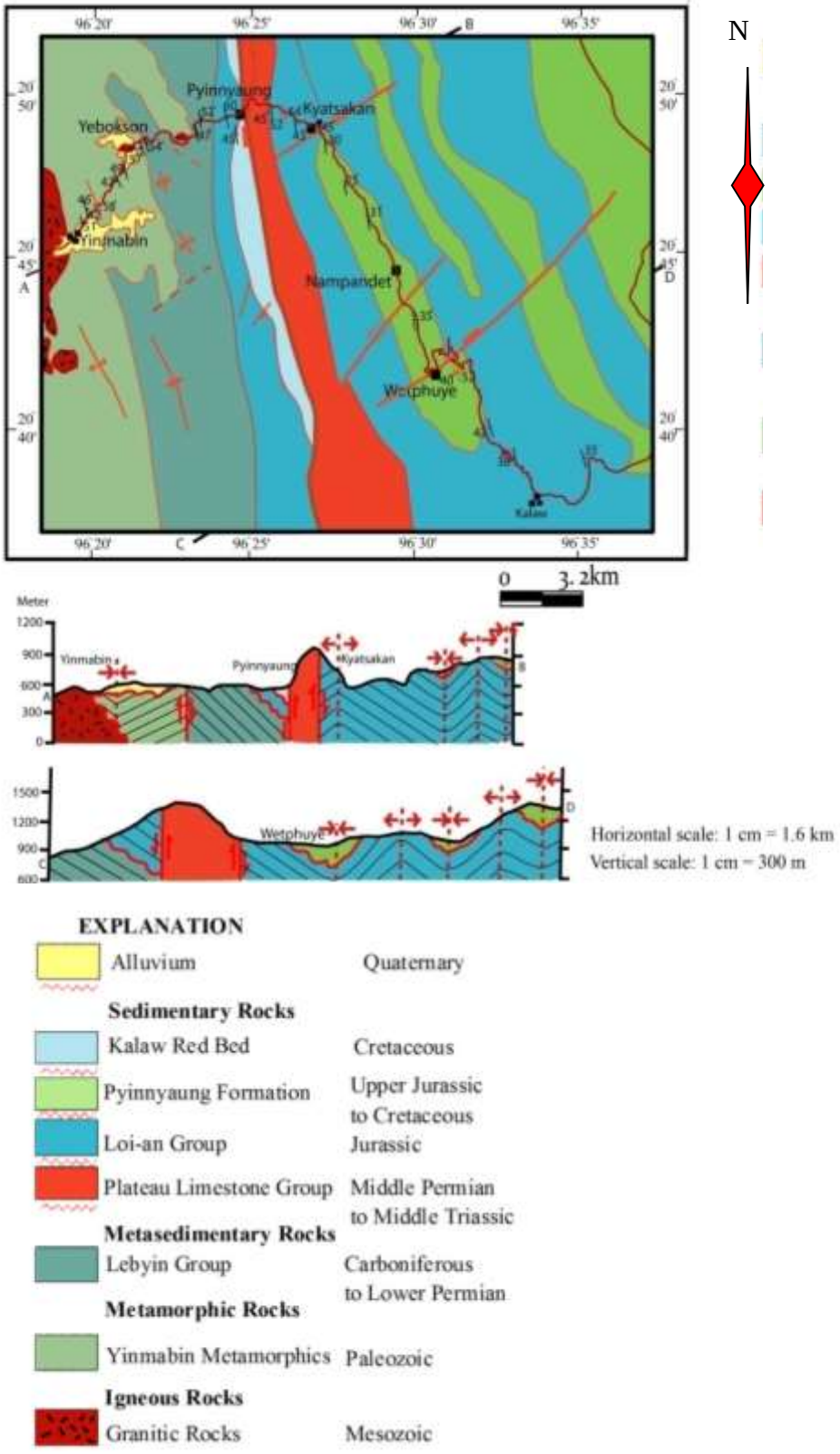

Figure 5 Geological map and cross-section of the research area

Methodology

Geological data collection, geotechnical data collection, and GIS application softwares are carried out to observe discriminated analysis and geotechnical interpretation.

All available geological reports contributed by the previous researchers and engineering geological text books, journals and research papers as well as meteorological data were studied carefully for references as useful guide.

Topographic map interpretation was carried out using the UTM map No. 2096-05, 2096-06, 2096-09 and 2096-10 from Survey Department (Ministry of Forestry). The topographic features, elevation contrast and terrain analyses, their trends, drainage systems in relation to structural controlled features were interpreted.

The rock mass rating (RMR) was computed according to (Bieniawski, 1989) proposal, with adding rating values for five parameters: i) strength of intact rock, ii) RQD, iii) spacing of discontinuities, iv) condition of discontinuities, and v) water inflow through discontinuities and/ or pore pressure ratio.

The strength of the rock mass is measured by using Schimdt hammer test as well as point load test of laboratory tests (Romana, 1993). The volumetric joint count was used to measure by using the formula of Jv = 1/S1+1/S2+1/S3+---+Nr/5, where Nr means the numbers of random joints to determine the RQD. It is not possible to obtain good correlations between RQD and Jv. Palmström (1982) presented the following simple expression, which is frequently used: RQD = 115 - 3.3 Jv.

Geomechanic classification of Rock Mass Rating (RMR) (Bieniawski, 1989) system has been used to find Slope Mass Rating (SMR) (Romana, 1993). The “Slope Mass Rating” (SMR) is obtained from RMR by adding a factorial adjustment factor; depending on the relative orientation of joints and slopes and another adjustment factor depending on the method of rock slope excavation. Field observations and measurements of discontinuities are the main method for finding the SMR.

The discontinuities are oriented in such a way that they contribute to create wedge, planar, or toppling failures in many hillslope areas. They are not relatively difficult to analyze. Hence, the use of empirical design and rock mass classification becomes important.

The stereographic method of kinematic analysis (Goodman, 1998, Jeongi-gi Um and Kulatilake, 2001) is particularly useful for assessment of the stability of discontinuity planes. Slope orientation, discontinuity sets orientation and friction angle of the each Formation in the research area are used for kinematic analysis as the three main parameters. Data of the strike and dip values of slopes and discontinuities have been obtained from a discontinuity survey and pole plot, respectively. The slope face is shown as a great circle and the friction angle is represented by an interior circle.

By using the ArcGIS 10.1 (GIS software), the Digital Elevation Model (DEM) image with 30 meter resolution and Landsat-8 Thermatic Mapper (TM) image with 30 meter resolution were extracted from the specific area by using spatial analysis tools for the GIS application.

The Cut and Fill tool enables to create a hillslope changes map based on two input TM image with 30 meter resolution before and after 5 year intervals addition to Arc GIS 10.1 (GIS software) displaying the study area and volumes of surface materials that have been modified by the removal or addition of surface material.

Then, the identification and analysis of the slope, curvature, aspect, hillshade, slope direction of the spatial analyst extension had made the geoprocessing on a rich set of spatial analysis and modeling tools for both raster (cell-based) and feature (vector) data.

By using Envi (4.7) remote sensing, vegetation delineation and stress detection were made to examine the Normalized Difference Vegetation Index (NDVI) which generates an image that ranges from -1.0 to 1.0. Pixels with no vegetation tend towards -1.0, while pixels with vigorous vegetation tend towards 1.0.

Then, DEM images were built with agisoft photoscan software, digital photos which have taken by drone with 4k resolution. The obtaining DEM images are used to explore the gullies erosion where the streams and road alignment are cutting by combining with Arc GIS 10.1 software.

The analysis, identification and interpretation of landslides have been classified on the field observations by using the classification of landslide types of Varnes, 1978 and Keefer, 1984.

Landslide Susceptibility Zonation (LSZ) relies on a rather complex knowledge of slope movements and their controlling parameters. The reliability of landslide susceptibility maps depends mostly on the amount and quality of available data, the working scale and the selection of the appropriate methodology of analysis and modeling. The process of creating these maps involves several qualitative or quantitative approaches (Soeters and Van Westen, 1996; Aleotti and Chowdhury, 1999; Guzzetti *et. al*., 1999; Onagh *et. al*., 2012).

Results and Discussions

Past Landslides

The research area consists of hilly terrain with steep slopes, geologically unstable structure. Landslides occur in all rock types of igneous, sedimentary and metamorphic rocks which were exposed along the road between Yinmabin-Kalaw. Recently, there has been more an increase in deforestation. Thus, natural and manmade hillside cutting will cause more landslides.

Rock falls, debris flows and creep commonly occur in this area as shown in Figures (6) to (9). Their width and length of landslide areas related to slope height are described in Table (1).

Table 1 Sizes of landslide related with slope height

Sr. No.	Location	Type of Landslide	Area		
			Width	Length	Slope Height
1	N20°45'3.0",E96°17'17.9"	Rockfalls	5 m	25 m	15 m
2	N20°45'01.5",E96°17'22.2"	Rockfalls	5 m	25 m	15 m
3	N20°45'09.9",E96°17'23.1"	Rockfalls	10 m	30 m	30 m
4	N20°45'06.7",E96°17'23.6"	Rockfalls	13 m	250 m	25 m
5	N20°45'11.0",E96°17'25.2"	Rockfalls	10 m	130 m	20 m
6	N20°45'10.1",E96°17'27.4"	Rockfalls	3m	20 m	20 m
7	N20°45'09.5",E96°17'34.3"	Creep	15 m	30 m	35 m
8	N20°45'10.5",E96°17'39.2"	Creep	13 m	11 m	50 m
9	N20°48'26.2" E96°21'30.6"	Rockfalls	7 m	3 m	5 m
10	N20°48'34.3",E96°21'42.4"	Debris flow	20 m	45 m	24 m
11	N20°48'35.6",E96°21'42.8"	Debris flow	53 m	50 m	100 m
12	N20°48'34.3",E96°21'42.4"	Rockfall	11 m	12 m	45 m
13	N20°49'38.6",E96°24'33.5"	Rockfall	20 m	70 m	100 m
14	N20°49'28.4",E96°25'32.2"	Rockfall	5 m	3 m	13 m
15	N20°49'15.7",E96°25'48.3"	Rockfall	4 m	3 m	12 m
16	N20°49'21.6",E96°25'38.2"	Creep	5 m	3 m	5 m
17	N20°49'1.1",E96°26'10.1"	Creep	15 m	12 m	20 m
18	N20°49'14.0",E96°25'51.9"	Debris flow	25 m	40 m	30 m
19	N20°49'0.0",E96°26'15.9"	Debris flow	15 m	10 m	45 m
20	N20°49'1.6", E96°26'24"	Rockfall	6 m	5 m	30 m
21	N20°48'56.5", E96°26'34.2"	Rockfall	8 m	5 m	40 m
22	N20°47'10.7", E96°28'30.2"	Debris flow	10 m	7 m	12 m
23	N20°47'12.7", E96°27'47.8"	Debris flow	15 m	7 m	11 m
24	N20°47'7.5", E96°27'52.3"	Debris flow	14 m	5 m	10 m
25	N20°41'29.1", E96°30'14.6"	Creep	150 m	40 m	110 m
26	N20°42'22.5", E96°30'12.4"	Rockfall	55 m	30 m	70 m
27	N20°42'23.1", E96°30'13.2"	Creep	7 m	15 m	30 m
28	N20°42'09.7", E96°30'14.1"	Rockfall	27 m	10 m	55 m
29	N20°42'00.1", E96°31'25.6"	Creep	40 m	30 m	70 m
30	N20°41'24.0", E96°31'43.7"	Creep	20 m	7 m	45 m
31	N20°40'46.5", E96°31'52.0"	Debris flow	5 m	7 m	25 m
32	N20°40'22.4", E96°32'40.0"	Slump	20 m	15 m	35 m
33	N20°40'31.1", E96°32'58.2"	Slump	25 m	20 m	30 m

Figure 6 Rockfalls in the calc-phyllite unit at the western part of study area

Figure 7 Debris flow on composite slope at the central part of the research area

Figure 8 Creep due to stream bank erosion at the western part of the research area

Figure 9 Occasional slump in residual soil at the eastern part of the research area

Landslide distributions

There are four kinds of potential landslide types in the study area. Among them, rockfall hazard has a highest potential of 49 percent (Figure 10). The maximum numbers of potential rockfall site is associated with Yinmabin Metamorphics. Such potential rockfall sites are also

identified in rest of the rock groups (Lebyin Group, Loi-an Group and Kalaw Red Bed), and the minimum rockfall potential site is related to Plateau Limestone Group (Figure 11). Debris flow occurrence potential could be higher in the composite slopes belonging to the Lebyin Group, Loi-an Group and Kalaw Red Bed. Potential debris flows, creeps and slumps are also identified in the residual soil.

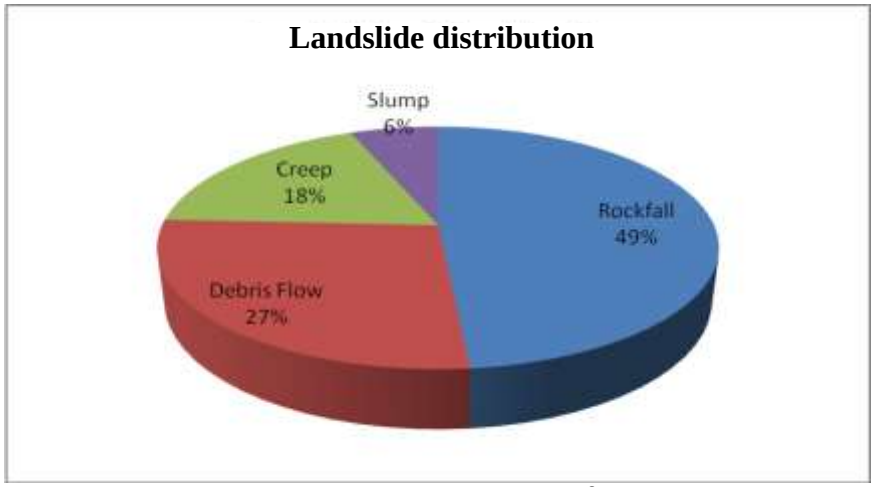

Figure 10 Landslide distribution of the research area

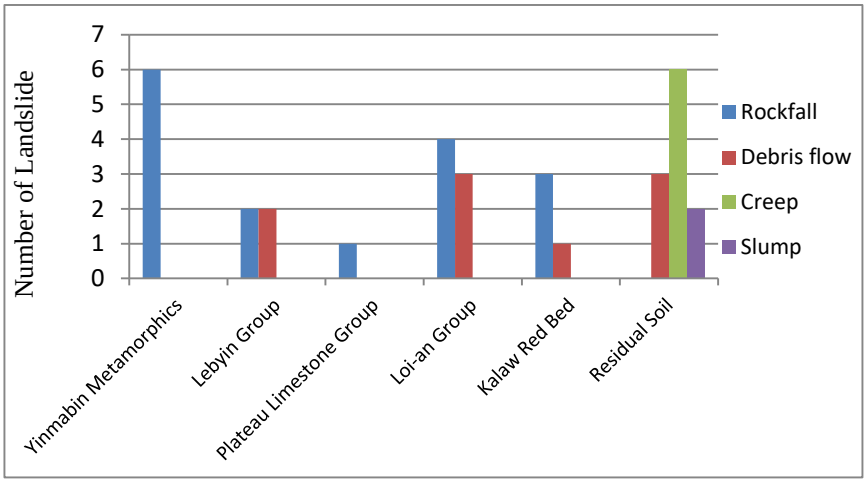

Figure 11 Landslide distribution in all rock units

Preventive Measures for Landslide

Analysis on Geotechnical Parameters

Field data collections such as

1. slope parameters,
2. geological structures,
3. rock mass characteristics,
4. existing mitigation measures,
5. gully erosion,
6. observation landslide movement indicators,
7. landslide failure types,

8. vegetations and measurements for slope stability along the road between Yinmabin (Mandalay Region) and Kalaw (Shan State) have been carried out. Using the collected field data, Slope Mass Rating values are determined to assess the possible slope conditions. The results are tabulated in Table (2). Four slope conditions have been identified as:

a) Very low hazard zone

b) Low hazard zone

c) Medium hazard zone and

d) High hazard zone.

Table 2 Landslide hazard zone analysis based on slope mass rating

Site No	Slope Mass Class	Possible Slope Conditions
1	Unstable	High hazard zone
2	Partially stable	Medium hazard zone
3	Completely unstable	High hazard zone
4	Partially stable	Low hazard zone
5	Partially stable	Low hazard zone
6	Completely unstable	High hazard zone
7	Unstable	Medium hazard zone
8	Partially stable	Low hazard zone
9	Partially stable	Low hazard zone
10	Partially stable	Low hazard zone
11	Completely unstable	High hazard zone
12	Stable	Very low hazard zone
13	Partially stable	Low hazard zone
14	Unstable	Medium hazard zone
15	Partially stable	Low hazard zone
16	Completely unstable	High hazard zone
17	Partially stable	Low hazard zone
18	Completely unstable	High hazard zone
19	Partially stable	Low hazard zone
20	Partially stable	Low hazard zone
21	Partially stable	Low hazard zone
22	Completely unstable	High hazard zone
23	Partially stable	Low hazard zone

Site No	Slope Mass Class	Possible Slope Conditions
24	Partially stable	Low hazard zone
25	Partially stable	Low hazard zone
26	Stable	Very low hazard zone
27	Completely unstable	High hazard zone
28	Partially stable	Low hazard zone
29	Partially stable	Low hazard zone
30	Partially stable	Low hazard zone
31	Unstable	Medium hazard zone
32	Partially stable	Low hazard zone
33	Partially stable	Low hazard zone
34	Partially stable	Low hazard zone
35	Partially stable	Low hazard zone
36	Partially stable	Low hazard zone
37	Partially stable	Low hazard zone
38	Partially stable	Low hazard zone
39	Partially stable	Low hazard zone
40	Unstable	Medium hazard zone
41	Unstable	Medium hazard zone
42	Partially stable	Low hazard zone
43	Partially stable	Low hazard zone
44	Unstable	Medium hazard zone
45	Completely unstable	High hazard zone
46	Unstable	Medium hazard zone
47	Partially stable	Low hazard zone
48	Partially stable	Low hazard zone
49	Stable	Very low hazard zone
50	Unstable	Medium hazard zone
51	Partially stable	Low hazard zone
52	Stable	Very low hazard zone
53	Stable	Very low hazard zone
54	Stable	Very low hazard zone

Sites 1, 3, 6, 11, 16, 18, 22, 27 and 45 assessed as high hazard sites. Thus, appropriate supporting systems such as retaining structures with slope drainage for slope stability need to be considered as soon as possible.

Sites 2, 7, 14, 31, 40, 41, 44, 46 and 50 are assessed as medium hazard sites. These sites are also required the long-term stabilization such as shotcrete with wire mesh, slope drainage and rockbolt, or a combination of those supporting systems which are deemed suitable.

The identified low hazard sites are 4, 5, 8, 9, 10, 13, 15, 17, 19, 20, 21, 23, 24, 25, 28, 29, 30, 32, 33, 34, 35, 36, 37, 38, 39, 42, 43, 47, 48 and 51 whereby, removable of slope debris and unstable rock overhangs, reshaping slope geometry, revegetation, surface drainages and precaution signage prior to the rainy season. The rest of the sites (12, 26, 49, 52, 53 and 54) are stable.

Rock Trap Design Determinations for Selected Rockfall Sites

The stability of rock slopes is sensitive to the slope height, behavior of rock types, weathering rate and vegetation. In accordance with Burt (2007), most of the slope inclinations of the research area can be identified as extremely steep and sub-vertical slope. Weathering grade of the rockfall sites range from slightly weathered to highly weathered with medium to high joint density. These sites experienced minor to major rockfall throughout the year and rainy season in particular. Hence, hazard reduction is essential. One of the low cost hazard reduction measures which the author considered suitable for those rockfall sites is to construct rock trap ditches. In due course, Whiteside (1986) ditch design method is used for the design measures of the rockfall sites and the schematic diagram of typical ditch is presented in Figure (12).

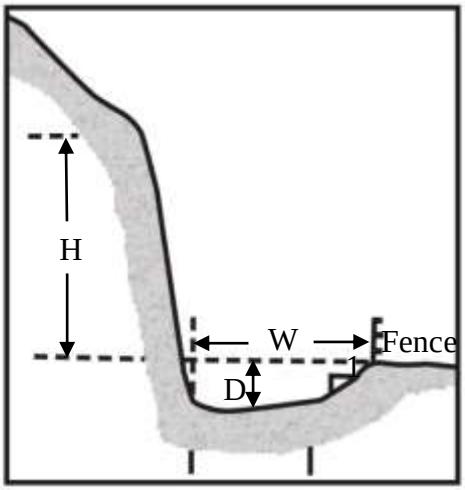

Figure 12 Designed criteria for shaped ditches to catch falling rock (after Ritchie, 1963, and Piteau and Peckover, 1978)

Development of Engineering Geological Map

Engineering geological map was produced based on the geological and geotechnical data, which include rock types, geological structures, geomorphological features, gully erosions, landslide types, rock strengths, rock mass rating and slope mass rating which is described in Figure (13) in Chapter V. The engineering geological map indicates that rockfalls are mostly found in the western part of the road especially west of Yinmabin, the area between Yebokson and Pyinnyaung

and the area between Pyinnyaung and Kyatsakan. Debris flows and creeps originating in the composite slopes are located between Nampandet and Wetphuye area.

There are three landslide hazard zones which are characterized by the above geological and geotechnical parameters. These zones are

1. Landslide Hazard Zone I (located in the west of Yinmabin),
2. Landslide Hazard Zone II (located in the eastern part of Yebokson and western part of Kyatsakan) and
3. Landslide Hazard Zone III (located between Nampandet and Wetphuye).

Landslide Hazard Zone I consists of highly jointed, weak and very weak Yinmabin Metamorphic rocks. This zone has been assessed as unstable slope and completely unstable slope based on slope mass rating (SMR).

Landslide Hazard Zone II consists of weak rocks (Low RMR) of Loi-an Group and is associated with Pyinnyaung fault zone. Majority of the sites are unstable slopes according to slope mass rating (SMR).

Landslide Hazard Zone III comprises weak siltstone unit (Kalaw Red Bed) and some of the sites (less than six in number) are assessed as unstable slopes.

Gully erosion of moderate intensity generally occurred along the intermittent streams located between Kyatsakan and Nampandet areas. However, gully erosions are much higher (high intensity) along the permanent streams, and in the area where the road cross over the stream.

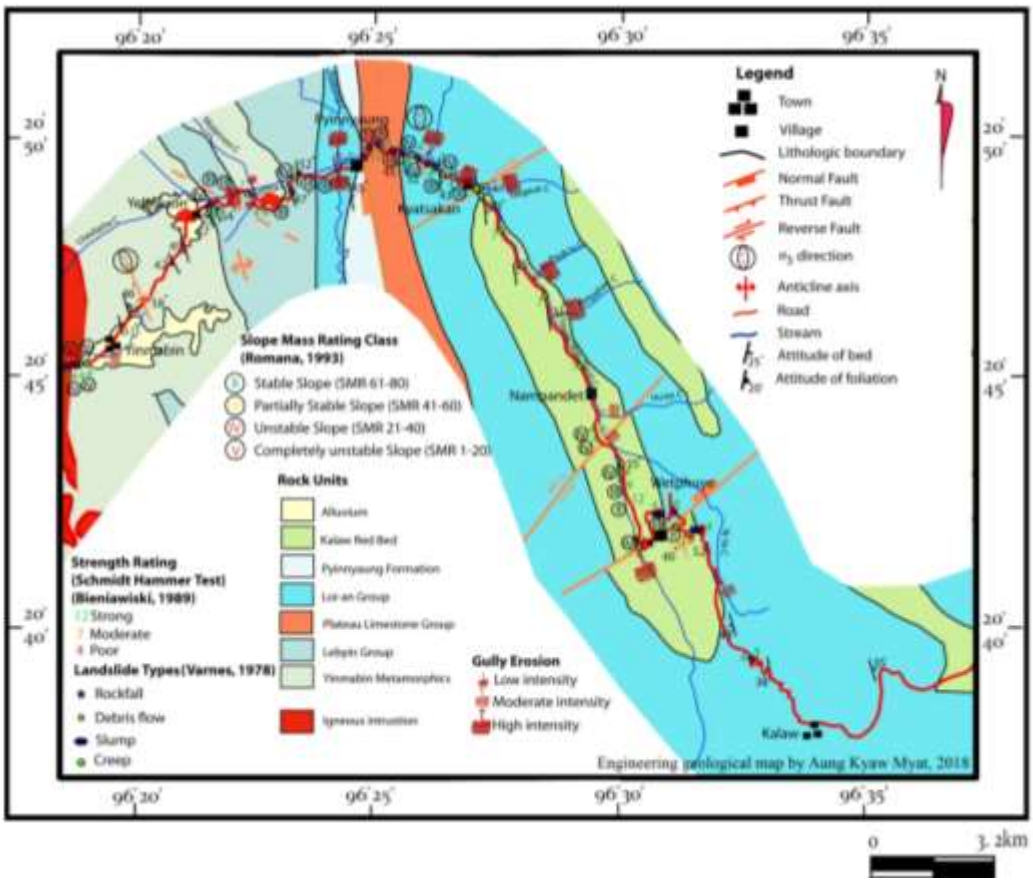

Figure 13 Engineering geological map of the research area

Preventive Measures for Slope Stabilization

Unstable slopes are practically mitigated by introducing active and passive support.

Active support is said to act in a manner to decrease the driving force. For example, grouted tiebacks, tensioned cables or rockbolts are active support as they exert a force on the sliding mass before any movement has taken place.

On the other hand, passive support increases the resisting force. Soil nails and geotextile are the good examples of passive support, as they only develop a resisting force after some movement within the slope has taken place.

(a) Surface treatment

Hazard reduction can be achieved through surface treatments to stabilize or remove relatively small blocks of rock. In the metamorphic rock terrain of research area, rock trap ditches combined with toe zone fence are used with the sufficient width for the protection of rockfalls.

Moreover, wire mesh is also used for temporary faces integrated with the sequencing of the slope excavation for the new rock slopes and upgrading works for existing slopes. The purpose of the mesh is not to prevent rockfalls but to control it by trapping blocks between the mesh and the rock face. In the sedimentary rock terrain, especially the slopes that composed of the rocks of Loi-an Group, there is a temptation to use hard slope treatments like shotcrete combined with wire mesh, drain pipe placing 1 m interval and rock bolts to constrain loose blocks at the slope surface.

(b) Retention

Rock traps are also constructed as excavated ditches, deformable barriers such banks of fill or gabion structures and walls at the toe of slopes adjacent to highways. Uncompact gravel is placed on the floor of trap to absorb energy from falling blocks.

If the slopes are too high, especially in Pyinnyaung area, where ramp or bench is difficult and the hazard mitigation may be problematic. Under such conditions, draping surface mesh should be used achievement of some effective protection, preventing progressive ski-jump-style or the style of bouncing of rock down the slope (Carter and Bentlay, 2002).

(c) Drainage

There are lacks systematic surface drainage and underground drainage pipes in this area. Thus, the systematic drainage pipes with designing layout of surface treatment for long-term access should be built in the most of the slopes along the road. Heights of individual slopes are also important considerably and safety for inspections as well as maintenance works including repair, cleaning of drains, tensioning and replacing support elements. Besides, as a basic stabilization measure for rock slopes, drainage works are appropriate, during and after excavation as well as in every slope. And, the sub-surface drainage can be effective in reducing the potential development of adverse water pressure, but there must be target sub-surface flow channel, Figure (14).

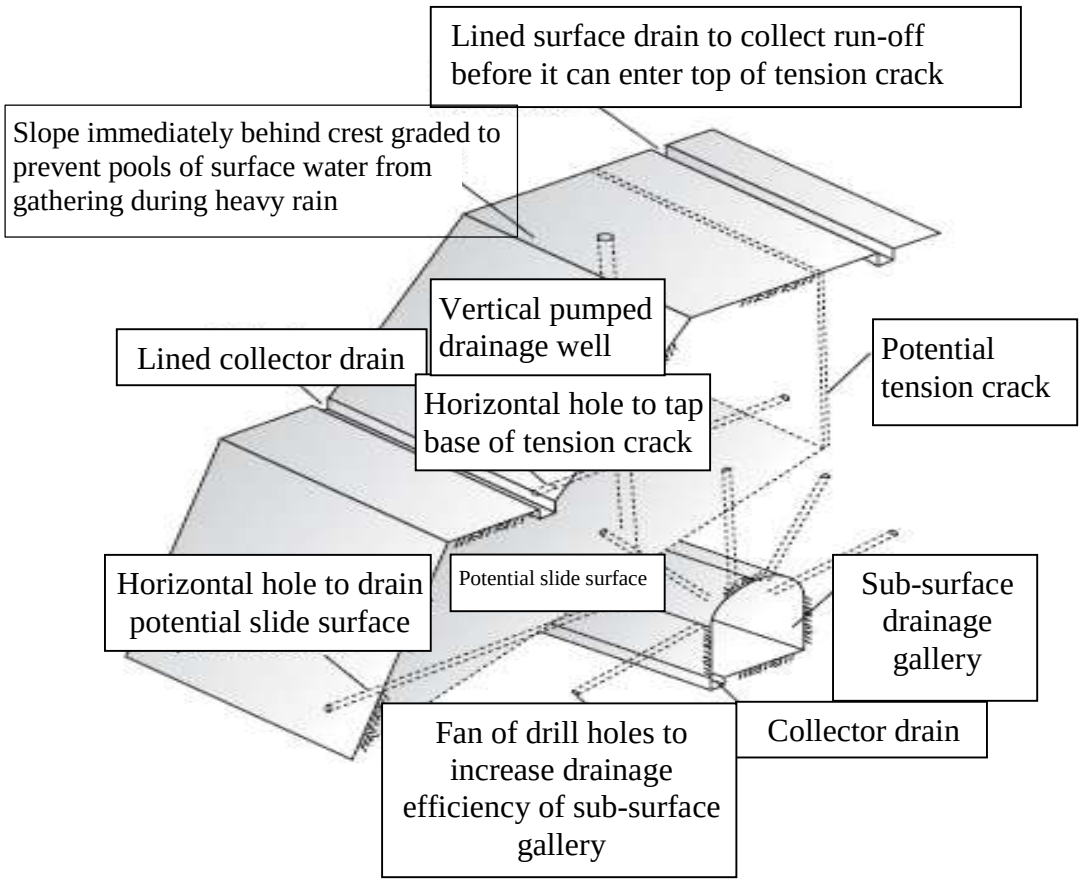

Figure 14 Slope drainage methods (After, Wyllie and Christophere, 2003)

(d) Reinforcement

Slope may be reinforced using anchored structures. Rock bolts with bar tendons are particularly useful where plane failures and wedge failures are likely to occur. The principal of rock bolts is to integrate rock plates together so as to form monolithic mosaic. The measures are basically preventive in nature and minimize future failures of rock.

The mechanism of load transfer from anchor relies on band at the soil-grout interface and tendon grout interface, rather than soil frictional resistance. The length of earth or rock anchors in the fixed anchor zone varies depending on the degree of consolidation of soil material on nature and degree of weathering bed rock.

The most favourable retaining structure is constructed with various methods. Therefore, the slope failures can be reduced by lateral earth support system. Some mitigation measures from Figure (15) could be useful for Sites 6, 10, 29, 30, 31, 32, 45, 48, 49 and 53 of the study area because these sites are situated in fault zone.

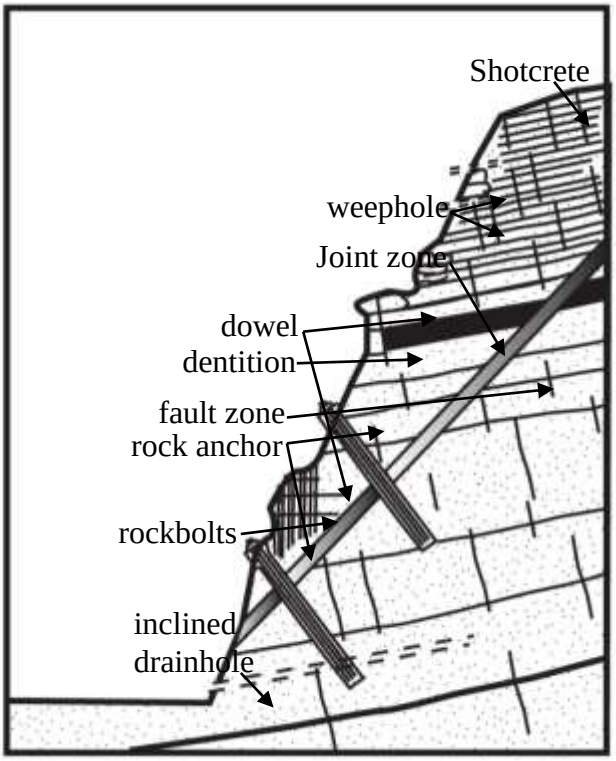

Figure 15 Various methods for stabilizing rock slope (From Geotechnical Control Office, Hong Kong, 1984)

(e) Retaining walls

Retaining walls can be constructed to prevent smaller sized and secondary landslides that often occurring along the toe portion of the larger landslides. These walls constructed from concrete cribbing, gabions (stone filled wire baskets) or piles (long concrete, steel or wooden beams driven into ground) are designed to provide support at the base of a slope.

Gabion wall may be suitable for the road section between Kyatsakan and Nampandet and would also protect the road embankment from erosion or undercutting by Taung Wun Dwin Chaung. Wire mesh should be applied to catch the rock fall above the existing retaining wall along the road between Pyinnyaung and Kyatsakan.

Conclusions and Recommendations

The research area is located in the western part of the Eastern Highland along the Thazi-Taunggyi transportation route, between Yinmabin (Mandalay Region) and Kalaw (Shan State). This area is mainly composed of sedimentary rocks, limestone which belongs to Plateau Limestone Group, sandstone and shale alternate unit of Loi-an Group, sandstone and shale alternate unit of Pyinnyaung Formation, red siltstone and conglomerate of Kalaw Red Beds and sandy soils and colluviums of Alluvium, metamorphic rocks such as calc-phyllite, sandy phyllite, spotted phyllite and slate of Yinmabin Metamorphics with granitic intrusions.

Rainy season generally starts in May and ends in October. However, light showers can be expected before May and after October. Heavy rainfall can be considered as a triggering factor as most of the big landslidings occur in August 2011, 2017 and 2018 which happens to be maximum rainfall months.

The western part of the research area consists of highly deformed zone of Yinmabin Metamorphic Complex. The middle part of the area is associated with shear zone of Shan Scarp Fault, and the eastern part is also faulted and highly elevated.

Four types of landslide (rockfalls, debris flows, creeps and slumps) occurred along the road. The most common landslide type found along the road is rockfall which is associated with the cutting faces along the road within the research area. These slopes comprise phyllite, limestone, sandstone and shale alternate unit, siltstone and conglomerate. Most hazardous landslide type is a debris flow occurred on August in 2017 at the western part of the Pyinnyaung. Most of the creeps are formed by erosion of main streams and its tributaries on both sides of the road. Slumps are found at the cutting slopes consisting of thick residual soil of Kalaw Red Bed.

Joint density analysis reveals that some phyllite of the Yinmabin Metamorphics, some sandstone and shale alternate units belonging to the Loi-an Group and some red siltstone components of Kalaw Red Bed exhibit high joint density, is most likely to attribute unstable slope conditions. Some igneous rock units of Yinmabin area, limestone unit of the Plateau Limestone Group and red conglomerate unit of Kalaw Red Bed have low to very low joint density with high rock strength. Hence, they exhibit stable slope condition. Most of the rocks unit at the middle part of the transportation route have moderate joint density and are located within the shear zone Shan Scarp.

The weathering grade of the research area ranges from Grade (III) to (VI). The weathering condition of granitic rocks is Grade (III). The rocks of the Loi-an Group and Kalaw Red Bed have been considered as Grade (IV). The unit which belongs to Yinmabin Metamorphics is of Grade (V). The residual soil located within composite slope belonging to Yinmabin Metamorphics, Loi-an Group and Kalaw Red Bed have Grade (VI) weathering conditions.

Three landslide hazard zones for landslide are identified. They are (1) Landslide Hazard Zone I (located in the west of Yinmabin), (2) Landslide Hazard Zone II (located in the eastern part of Yebokson and western part of Kyatsakan) and (3) Landslide Hazard Zone III (located between Nampandet and Wetphuye). The hazard could be reduced by reshaping the slope that is to reduce the slope inclination for less than 45° depending on the orientation, the density of discontinuities and mode of failures.

Landslide susceptible map indicates Pyinnyaung-Kyatsakan and Nampandet-Wetphuye areas are highly elevated consisting of steep cutting slopes (slope angle >50°), very much susceptible to landslide because they are facing toward the road. The western part of Yinmabin, east of Yebokson and Kalaw areas are also highly elevated with moderately steep slopes (slope angle between 20°-50°). The area between Yinmabin and Yebokson and western part of the Pyinnyaung village are low relief area, hence the least susceptible to landslide. Other important feature of landslides along the road is stream erosion and soil creep. The road sections on either side of Myittha Chaung and Taung Wun Dwin Chaung are mainly affected by stream erosions.

Recommendations for General Remedial Measures

The sites in Landslide Hazard Zone I located west of Yinmabin which are devoid of rockfall and which are mainly composed of residual soils, reshaping the slope geometry and/or installation of drainage system may be appropriate.

The sites in Landslide Hazard Zone II with the exception of rockfall sites between the eastern part of Yebokson and western part of Kyatsakan where the sites are classified as completely unstable and unstable slopes associated with high joint density, such sites should be reshaped. Whereby, slope inclination (<45°) is desirable together with grass plantation and surface drainage is recommended.

The sites in Landslide Hazard Zone III located between Nampandet and Wetphuye, mitigation measures should include reshaping of the slope inclination to less than 45° together with concrete buttress and subsurface drainage.

In the composite slopes of Pyinnyaung-Kyatsakan area, wire mesh and rockbolt should be installed over the existing retaining structures to protect further rocks and debris falling over the present retaining structures.

In the stream bank immediately located which is close to the road between Kyatsakan and Nampandet, the suitable mitigation measures would be gabion wall with systematic drainage system.

The precaution warning signs need to be installed in the landslide hazard area.

Recommendations for Specific Remedial Measures

Sites 3, 4, 5 (Landslide Hazard Zone I) which are located in the low elevated area could be reshaped including cutting bench if necessary, with surface drainage at the toe of the slope.

In Sites 27, 33 and 44 (composite slopes) of the existing debris flow sites, the remedial measures for retaining structures with slope drainages are recommended.

As for sites 52 and 53, the slope geometry should be reshaped the slope inclination to less than 45° together with concrete buttress and subsurface drainage.

Sites 29, 30 and 31 located in the highly elevated Pyinnyaung Fault Zone comprising brecciated limestones should be remediated with rockbolts and slope drainages.

Recommendations for Future Research

Further detailed case studies of the sites located at the high hazard zone (for example sites 27, 52 and 53) should be carried out for the slope stability analysis. Systematic soil and rock samplings and laboratory analyses are required.

Geotechnical investigation works like cored drilling may be necessary to supplement and further installation of suitable slope monitoring system is recommended.

Remedial and mitigation measures seem to be inadequate during the reconstruction and widening of Yinmabin-Kalaw highway road. Additional risk assessment study is recommended for prioritizing the necessary mitigation measures and safety of the commuters.

Recommendations for Public Education

For the safety purpose, landslide hazard education should be conducted.

Public education should also be carried out for the safety awareness of the wider community.

Natural hazards (cyclone, flood, earthquake, and tsunami) with particular to landslide hazard for these regions need to be included in the national education curriculum to broaden the knowledge base of the younger generation.

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BIOLOGY AND CULTURE OF GREEN MUSSEL *PERNA VIRIDIS* (LINNAEUS, 1758) FROM YE ESTUARY IN MON STATE

BIOLOGY AND CULTURE OF GREEN MUSSEL *PERNA VIRIDIS* (LINNAEUS, 1758) FROM YE ESTUARY IN MON STATE

Win Win Nwe[1]

Abstract

The study was conducted at Sitaw, Ye estuary (Lat. 15º 11' N, Long. 97º 48' E) from September 2015 to May 2018 and at Shwekyungyi (Russell Island: Lat. 10º 15' N, Long. 98º 15' E) from June 2018 to February 2019. A significant and high degree of positive correlation is between total length and weight of *Perna viridis*. Negative allometric relationship might be due to the difference in the growth rate between male and female mussels. The overall male to female sex ratio (1:0.67) was differed significantly from the expected 1:1 ratio. Distinct peaks in condition index (CI_{shwt}) and percent edibility ($CI_{commercial}$) were observed in June and October. Ripe gonads were in good numbers in January and March. Spawning took place during the extended period of time from February to December. Peak spawning coincided with a high fluctuation of salinity and temperature during early monsoon. Induced spawning was done by thermal stimulation and Thermal increase from 18 to 30ºC and the larvae were successfully reared to setting in the laboratory. Average shell length measurements and the survivability of larvae among antibiotic treatments and control was significantly different (ANOVA; $F_{4,57}$=5.72, p=0.001<0.05 & $F_{4,57}$=4.96, p=0.02<0.05). Average shell length and survival of larvae treated with a mixture of penicillin and streptomycin (T3) were higher and significantly different from that of the other larvae ($p < 0.001$ & Turkey test; $p = 0.013 < 0.05$). Detailed of larval shell development in the rearing tanks treated with different antibiotics were described. The spat fall of T3 larvae began on 21st day and continued up to the 39th day on spat collectors. The mussels seeded in the cages at Sitaw, Ye estuary, attained 90.03±11.46 mm in length within 1 year with a mean growth rate 7.40 mm/month. The asymptotic lengths (L∞) observed were 120.23 mm (cage culture) and 122.33 mm (rack-hanging culture). The mussel attained 53.24±7.99 mm within 9 months of culture period at Shwekyungyi. The environmental parameters of Ye estuary seem to favor for growth and high survival of mussel. The optimum sizes of around 10-25 mm mussels should be seeded and the culture period of around 5 months was optimum in a favorable season.

Keywords: Culture, growth, *Perna viridis*, spawning, Ye estuary.

Introduction

The green mussel, *Perna viridis* (Linnaeus, 1758) belongs to the Phylum Mollusca, Class Bivalvia and the Family Mytilidae. It is distributed widely in the Indo-Pacific regions. It is currently being recognized as a cheap protein sources, containing high nutritional values and it is popular for its delicious taste (Taib *et al*., 2016). *P. viridis* is an important seafood resource and this species is extensively cultured due to its high productivity, high tolerance to a wide range of environmental conditions and requiring less farm management (McFarland *et al*., 2013). Furthermore, the rapid growth rate also ensures that a commercial sized product can be reared in a short time period under farming conditions. Green mussel, *P. viridis* achieves marketable size relatively within a short culture period of about 6 months (Rajagopal *et al*., 1998a) a&b).

Commercial cultivation of marine mussel *Perna* is extensively carried out in several countries (FAO, 2017) especially in the Southeast Asian region. Thailand and Philippines are the major green mussel producers followed by India, Malaysia and Singapore. Nearly two hundred and eighty two thousand tonnes of *P. viridis* is produced worldwide per year through culture (FAO,

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2009). It forms a significant fishery and contributes nearly 50% to the total bivalve production in India (Laxmilatha *et al*., 2011).

Among bivalves, *Perna viridis* is one of the important species in the estuary ecosystem of Sitaw. The ethnic population from Ye estuary regularly harvests bivalves for their own consumption and daily income. Currently green mussels are becoming more important than other molluscs in this area because they rank second prize to the oysters. Other threats such as environmental degradation and habitat destruction due to overexploitation can also directly affect the mussel population. Therefore a reduction in the abundance of mussels can indicate a negative change in the estuary ecosystem.

The consuming of green mussel in Mon coastal area is only depended on the natural mussel beds. On the other hand, the mussel beds on the Sitaw coast are limited and scattered. The techniques for mass culture of *P. viridis* are required to fulfill the food requirement of local people and their employment at Sitaw, Ye estuary. According to the previous research on the spatfall of this species at Sitaw, the natural seed resource on the rocky intertidal beds cannot support mussel culture. The hatchery production of green mussel seeds in the laboratory, therefore, is attempted to carry out to initiate mussel production in Myanmar. The present study is the very first observation of larval rearing of *P. viridis* for the seed production and the first step to develop mussel seed production through the hatchery technique in Myanmar.

Objectives of Research

The objectives of the present investigation on biology and culture of green mussel, *Perna viridis* from Ye estuary are:

1. To study length-weight relationship of *P. viridis*
2. To know the spawning time, gonad development and condition index of *P. vriridis*
3. To investigate the larval development and metamorphosis of *P. viridis*
4. To determine population parameters and growth rates of *P. viridis*

Materials and Methods

3.1 Description of study areas

The study on the biology and culture of green mussel, *Perna viridis* was conducted at Sitaw, Ye estuary (Lat. 15º 11' N, Long. 97º 48' E), about three-fourth mile to the southeast across the mouth of Ye River, from Zeephyuthaung Village (Lat. 15º 15' N, Long. 98º 00' E), Ye Township, Mon State (Fig. 1: green circle, lower left map). For the laboratory culture, the experiment was carried out at Shwekyungyi (Russell Island: Lat. 10º 15' N, Long. 98º 15' E) from May, 2018 to February, 2019 (Fig. 1: orange circle, lower right map).

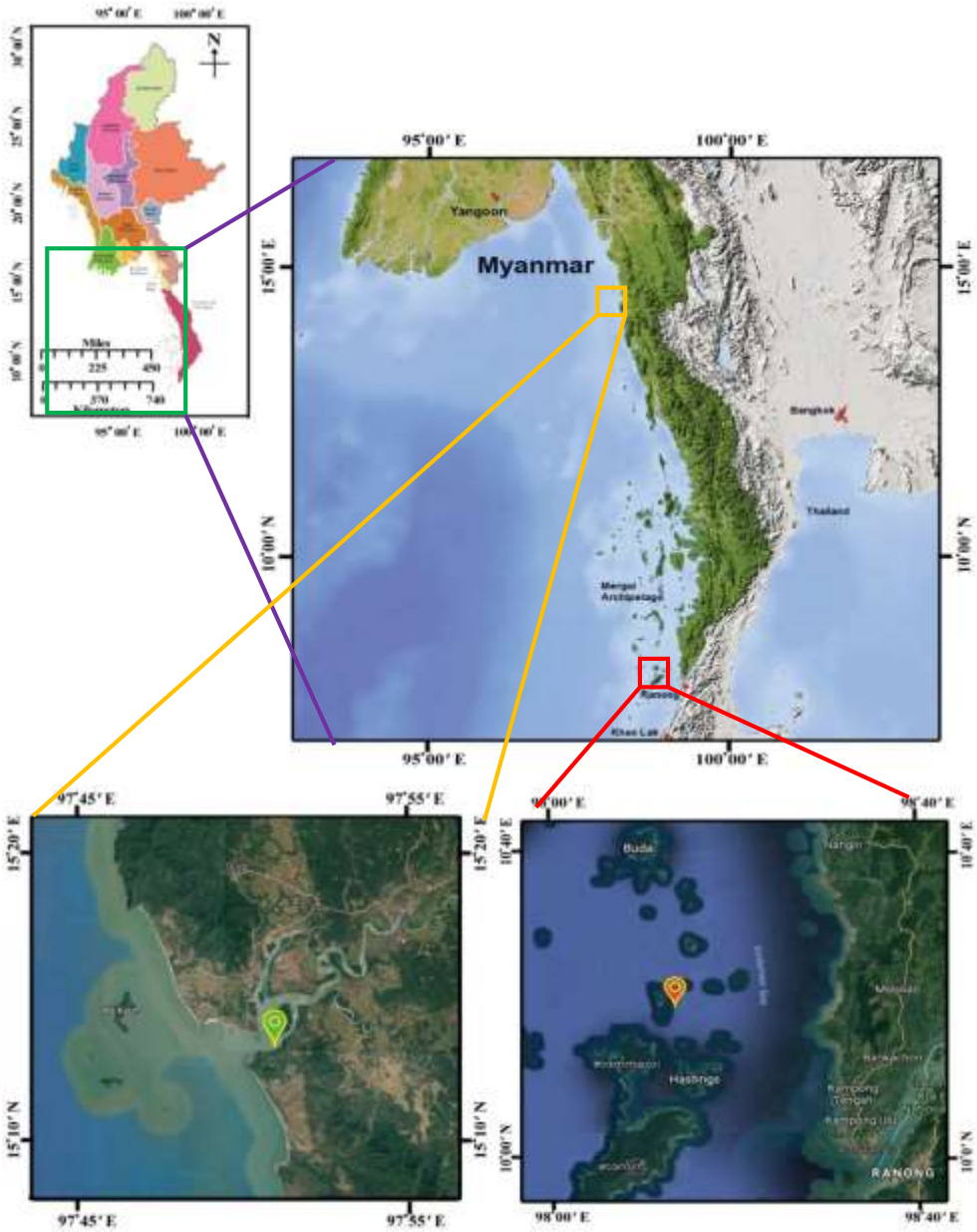

Figure 1 Map showing sample collection site and broodstock collection site in Sitaw (green circle, lower left map) and larval rearing site in Shwekyungyi (Russell Island) (orangel circle, lower right map) (Source: Google Maps).

3.2 Environmental parameters

The mean values of salinity, temperature and pH were recorded by using Horiba water monitor, refractometer and pH meter at monthly interval. The water parameters at Sitaw, Ye estuary were measured from January, 2016 to December, 2017. The data on monthly rainfall was obtained from Ye Township Meteorological Department. The water parameters at Shwekyungyi (Russell Island) were measured during grow-out culture period from June, 2018 to February, 2019. There were marked fluctuations in the salinity during monsoon seasons in Ye estuary. The average salinity of the surface water varied from 6.54 ‰ in August 2016 to 31.4‰ March 2016 and it also varied from 6.38‰ in June 2017 to 30.5‰ in March 2017. Surface water temperature ranged from

27.5°C to 32.2°C in 2016 and from 27°C to 32.6°C in 2017. During the experiments the pH range of the surface seawater was narrow, from 6.4 to 7.6 in 2016 and from 6.2 to 7.4 in 2017. Seasonal variations in environmental parameters of Sitaw are primarily influenced by the prevailing monsoon regime. During the study period, southwest monsoon commenced by the last week of May and the highest rainfall 1210.8 mm was recorded in August 2016 and 1628.14 mm in July 2017. In Shwekyungyi, the salinity varied from 30.16‰ to 32.83‰. Surface water temperature ranged from 27.36°C to 30.64 °C. The pH value ranged from 7.52 to 9.38.

3.3 Algometric and length-weight relationship

Perna viridis samples were randomly collected from the subtidal rocky natural mussel beds under about 10 meters at Ye estuary by the local mussel collector. Collection was made during low tide when the subtidal area of the sampling site was not affected by tidal current. Shell length (maximum distance between the anterior and posterior end of the shell), height (maximum dorso-ventral distance) and width (maximum distance between the lateral axis) of *P. viridis* were accurately measured to the nearest 0.01 mm using vernier calipers for their dimensions and other shell morphometric characteristics (Fig. 2 A-C). Mussels were then opened; tissue were removed from the shell and blotted to remove excess water in order to ensure accuracy before weighing the tissue. The individual weight of tissue and shell were then determined. Total weight was determined up to 0.01 g by using an electronic compact scale (SF-400A). The parameter 'b' of the length-weight relationship was estimated by using the general formula, $W = aL^b$ (Le-Cren, 1951; Park and Oh, 2002). The letter "W" is represented weight of the specimens in grams, "L" is length of the specimens in milimeters, "a" is the exponent describing the rate of change of weight with length and "b" is weight at unit length.The equation $W = aL^b$ can be expressed in linear form using natural logarithm as Log W=log a + b log L. When b = 3, increase in weight is isometric. When the value of b is other than 3, weight increase is allometric (positive if b>3, negative if b<3) (Sokal and Rohlf, 1987; Thomas, 2013).

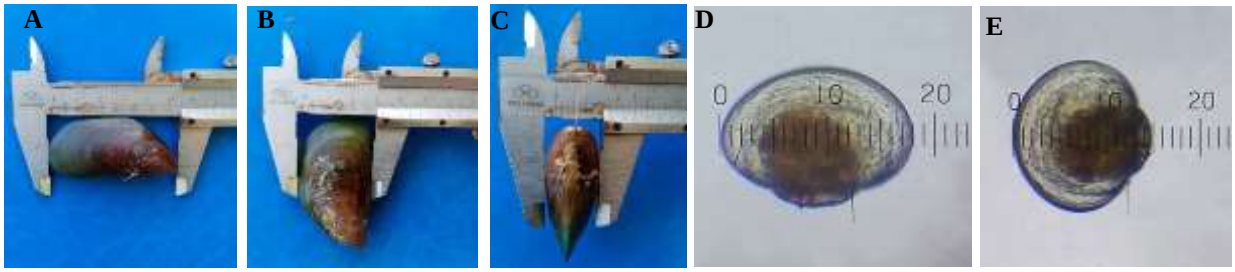

Figure 2 A-E. Biometric measurements of *Perna viridis*: **A**) shell length; **B**) shell height**; C**) shell width; **D**) larval shell length; **E**) larval shell height.

3.4 Gonad development and sex ratio

The gonads of 50 specimens were monthly examined for maturity studies. Tissue sections were cut and processed according to standard histological techniques (Howard *et al*., 2004). Sections of mantle, male and female gonads were immersed in Davidson's fixative (Shaw and Battle, 1957; Quayle and Newkirk, 1989) for one week. The fixed tissues were washed in running tap water over night and then dehydrated by the usual procedure in ascending grades of alcoholic series as-(50%, 70% and 90% alcohol for 1 h each, and 100% alcohol for 30 min each). The tissues were transferred to Alcohol-Acetone solution (1:1) for 30 min and soaked in xylem for thirty minutes to remove alcohol. After that tissues were infiltered in 2-3 changes of molten paraffin of

melting point 58-62°C, and then embedded in wax at 58-60°C and finally made into blocks which were labeled. Paraffin blocks were trimmed to suitable size and sections of tissue were cut using a microtome at 10 µm thickness. The resulting ribbons containing tissue sections were fixed on the glass slides using Mayer's egg albumin glycerol (1.1v/v) as an adhesive. Slides were placed in xylene to deparaffinize and were giving brief dips in grades of alcohol (70%, 90%, 100%- 20 minutes each) to dehydrate. Hydrated slides were stained in Herris' hematoxylin (2-5 min). Slides were mounted in DPX Mountant and cover slip applied and labeled. Thin layer of albumin was used as an adhesive. Sections were observed and photographed under compound microscope. Based on the distension of the gonads and microscopical examination, four stages of maturity were distinguished according to the results of Narasimham (1980) and Rajagopal (1991). Sex was identified separately for each specimen based on the color of gonad and mantle after removing the shell.

3.5 Condition index

For the study of condition index (CI), green mussels were randomly collected from the subtidal natural mussel bed of Ye estuary on a monthly basis. The collected mussels were cleaned and transported to the laboratory by using insulated box. Mussels were measured (using a digital Vernier calipers, ± 0.01 mm) and whole live weight and volume; shucked dry shell volume and weight; shucked wet meat weight and dry (80°C, 48 h) soft tissue weight were determined for each individual mussel and the condition index was estimated. CI_{shwt} recommended by Lucus and Beninger (1985) was used for calculating mussel condition index (CI).

$$CI_{shwt} = \frac{\text{Dry soft tissue wt.(g) x 100}}{\text{Dry shell weight (g)}}$$

According to the recommendation of Hickman and Illingworth (1980), $CI_{commercial}$ (meat yield) was used for studying the variations in wet meat percentage (% edibility).

$$CI_{commercial}\ (\text{Meat yield}) = \frac{\text{Wet tissue wt.(g) x 100}}{\text{Whole (live) weight (g)}}$$

The monthly mean CI was calculated and CI ratio was calculated as:

$$CI_{ratio} = \bar{x}\,CI_{month} / (\bar{x}\,CI_{all\ month}).$$

Based on the values obtained, the monthly CI which exceeded its annual mean was classified as "high (CI ratio >1)" and the remaining as "low (CI ratio <1)" (Hickman *et al.*, 1991).

3.6 Laboratory culture

3.6.1 Broodstock collection

For the study of induced spawning, larval rearing, and grow out culture of the green mussel, 80 broodstocks were collected from Ye estuary in May, 2018. The collected broodstocks (Fig. 3A) were scrubbed off debris under running tap water and placed them in 0.03% sodium hypochlorite solution for 5 minutes to control protozoan and rotifer populations. Mussels were then rinsed with tap water for 2-3 minutes and placed them into an insulated box with ice (Fig. 3B). And then, they were transported to the pearl oyster hatchery of Belpearl Co.Ltd., Shwekyungyi (Russell Island) within 36 hours (Fig. 3C). The hatchery building has two rooms: one is 10m x 10m concrete building with suitable drainage facility in the concrete floor for larval rearing and the other one is 7 m x 7 m air-conditioned room which is provided for conditioning the brood stock and

rearing the microalgal food (Fig. 3C). In the laboratory, the broodstocks were held in running seawater and algae were provided (Fig. 3D).

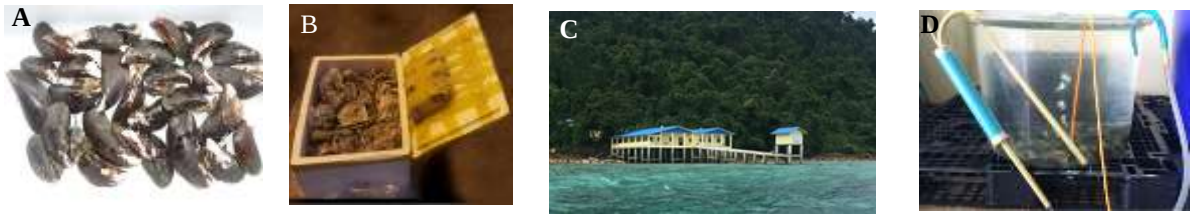

Figure 3. A-D. Sample collecting and transportation: **A**) *Perna viridis* specimens collected from Ye estuary; **B**) Transporting Broodstocks with an insulating ice box; **C**) Hatchery building in Shwekyungyi (Russell Island); **D**) Broodstock conditioning in running seawater.

3.6.2 Seawater preparation for culture

Seawater filtration system provided to the hatchery rooms is described as follows. Seawater was pumped from beyond low tide line and settled down in the first 500 L reservoir. Then it was filtered through 5 µ filter and 1 µ filter and then settled down in the second 500 L resevoir. Filtered seawater (FSW) was use for cleaning, larval rearing and mass production. For the algae culture, FSW was filtered again by using sterilized cotton filter. FSW is dispensed with P.V.C. pipes and air compressor provides aeration in the mussel larvae rearing.

3.6.3 Algae culture for larval feeding

Five algae species, *Isochrysis galbana*, *Chaetoceros calcitrans*, *Chaetoceros simplex*, *Chaetoceros gracilis* and *Chaetoceros ceratosporum*, were used for feeding the larvae. Prior to mass production of the algae, sub culture of required species is undertaken by serial dilution. Algae were grown in the medium at 18°C, in 3L fibre glass containers with oil free aeration (100 L/ 1min) supplied through glass tubing. Light was provided by four, 4 ft 40-watt fluorescent lamps with 500 lux for stock culture, 800 lux for subculture and 800-1500 lux for mass culture (Fig. 4A & 4B). Algae were harvested during exponential-phase growth. The algal culture facility can supply 30 L of axenic culture per day with a cell concentration of 0.5 to 1.0 million/mL. To feed the larvae, the algae were first examined under microscope to know the culture condition and to measure algae densities by using haemacytometer. Before feeding the mussel larvae, the algae were filtered through a 20 µm nylon mesh screen to remove debris and other protozoan (Fig. 4C). Larvae were fed live cultures of the mixture of algae *Isochrysis galbana* and *Chaetoceros calcitrans* starting from 2th day when the "D" shape was attained until the 7th day after which the larvae were fed five species of the mixture of the above-mentioned algae. Algal densities were gradually increased from 2.28-3.50 x 10^4 cells mL^{-1} to 5.2- 6.3 x 10^4 cells mL^{-1} as the larvae grew until 18 days rearing period and feeding was again increased from 6.2-7.3 x 10^4 cells mL^{-1} to 8.3-9.5 x 10^4 cells mL^{-1} until the larva settled as juveniles on the collectors (Fig. 4D).

Figure 4 A-D. Algae culture for larval feeding at Shwekyungyi (Russell Island): **A**) Stock culture; **B**) Sub culture and mass culture of microalgae**; C**) Filtering a mixture of five microalgae to feed the larvae; **D**) Spats (white spots) on the collectors.

3.6.4 Induced spawning and larval rearing

In order to induce artificial spawning in the laboratory, 10 mature male broodstocks and 30 mature female broodstocks were put in a water tank (50 L) which was filled with 32‰ FSW and kept alive at room temperature of 30°C for one day. The mussels were then first placed in air-condition room of temperature 18°C for one hour and then the specimens were transferred to a room of temperature 30°C in order to give a stimulus that induce artificial spawning. When aquaria became cloudy with eggs or sperm, spawning mussels were transferred into another 50 L tank. This was repeated until spawning ceased. The spawned eggs were filtered with 20 µm nylon mesh and placed into 200 L fiber glass tank filled with 100 L FSW. Gametes were examined under a microscope to determine the number of sperm attached to each egg. Because fertilization decreases when more than 100 sperms were attached per egg, sea water in culture tank was diluted as necessary to lower the sperm concentrations to approximately 100 sperms per egg. After the sperms were added into the tank, FSW was added up to 200 L. During cell division, one third of the surface seawater in the tank was changed every 30 minutes. It is important to ensure that the mesh of the sieve is always submerged during transfer to other containers.

Successful fertilization was confirmed via microscopy after 1 h by formation of polar bodies. After 2 h, the free swimming gastrula larvae were siphoned into another 200 L fiberglass tank. Larvae reached to D-hinge stage after 16-20 hours. The D-hinge larvae were screened by filtration through a series of meshes; 75 µm nylon mesh to remove debris, 41 µm to separate D-hinge larvae from trochophore larvae and 20 µm to remove abnormal larvae. The larvae were placed into 1000 ml FSW, mixed with a plastic stirrer and three 1-ml aliquots were counted under microscope to determine the density of larvae. The total number of eggs or larvae was calculated as follow:

$$\text{No. of egg or larvae} = \frac{\text{vol.of rearing tank}}{\text{vol.of sample}} \times \text{avg. eggs or larvae in sample}$$

After that, D-hinge larvae were placed into five 30 L tanks (Fig. 5A): four tanks (T1-T4) were filled with antibiotic treated FSW and one with natural seawater as a control experiment (T5). The antibiotics used in the experiment were 0.02 mg L^{-1} of penicillin, streptomycin, a mixture of penicillin and streptomycin, and chloramphenicol. Before the larvae (2 days old) were transferred to the respective larval rearing tanks, the antibiotic solution was added and strongly aerated. Antibiotics were added every three days during when the total volume of water in the culture tanks were changed. The seawater in the control tank was changed daily. Tanks were aerated for water circulation. Density in the tanks was 6 larvae mL^{-1}, in a total of c.a. 180,000 larvae in each tank.

During water change, the water is syphoned from the tank into a sieve with a mesh sufficiently large enough to retain larvae by submerging a mesh in the water container. The larvae were then graded by washing them through a stack of seives of descending apertures with FSW. Any sieved fraction containing dead and abnormal larvae were discarded. The healthy larvae were returned to the rearing tanks and adjust the aeration to the required level.The larvae were sampled to determine the total number of survival and to measure 30-40 larvae for calculating the mean shell length. A few drops of formalin were added to immobilize the larvae. This procedure was repeated at the next water change. In this mussel hatchery, the monthly mean variation of the water temperature is ranged from 27.4°C to 30.6°C, salinity from 30.1‰ to 31.48‰, dissolved oxygen from 5.04 ml/L to 6.5 ml/L and pH from 7.7 to 8.4.

When 80-90 % of larvae have reached the "eyed" stage after 18 days culture period, the collectors were set for the settlement of larvae. The collectors were made with 7 ft long black nylon ropes which were tied into 13 knots with weights. The collectors were first soaked in the algae tank and hung on the PVC pipes. They were then placed into the 200 L tank filled with natural seawater. The eye spot larvae were added into the middle of the tank and aerated with air stones. The water was change daily and bottom larvae were discarded. When the rate of spatfall on the collectors was 90 %, the spats were conditioned for two weeks in running seawater in a laboratory tank before deployment into the field (Fig. 5B).

Figure 5 A-B. **A**) Larval rearing in five tanks; **B**) Spat collecting with the collectors and supplying running water.

3.6.5 Calculation of larval growth and survival rate

To study morphological features of larval to post-larval shells during 18 days culture in the laboratory, 30 ml of seawater containing larvae was sampled and larvae were observed under optical microscope by using ocular meter. According to Bayne (1976), shell length was measured as the greatest dimension in a line parallel to the hinge (anteroposterior axis) (Fig. 2D), and shell height was measured as the perpendicular dorsoventral axis (Fig. 2E). Mean values of larval growth were acquired from 33 measurements per tank under optical microscope. Survival rates were measured daily during the culture period. The morphological characteristics of each larval stage observed were compared to those of *Perna viridis* described by Sreenivasan *et al*., (1988 and 1998), Laxmilatha *et al*., (2011) and Anil *et al*., (2017).

3.7 Grow-out culture at Sitaw, Ye estuary

For studying the mussel growth, a rack was placed in the subtidal zone of Ye estuary in May 2016 (Fig. 6A). The water depth was about 2 m at low water spring tide and about 7 m at high water spring tide. To construct a rack, four wooden poles (about 5 m long) were erected in placed with muddy bottom. Rack was fabricated using wooden poles lashed together with nylon ropes and nails. The submersible rack consists of a 4 m length and 2.5 m breath frame made of 8 cm thick wooden poles suitably joined at the ends by a cross halving joint with nylon ropes. Another pole

at the middle of frame acts as a rib providing the required strength. Eight wooden poles of two meters length are lashed to the frame with nylon cord at intervals of 0.75 m.

The seeded baskets and ropes are suspended from the rack, 0.5 m apart, with the lower free end of the rope about 0.5 m above the sea bed (Fig. 6A).

For studying the growth rate of cage culture, Juveniles 60 mussels were seeded in May 2016 and monthly samples were measured from May 2016 to April 2017. Young mussels (about 10 mm) were collected from their natural habitat in the intertidal rocky shore of Sitaw during the spawning season (Fig. 6B). A chisel or knife was used to scrape off the young mussels from the intertidal rocks. The plastic rectangular baskets (2ft length ×1.5ft length × 1ft height) were used as the cages for mussel growth. The collected young mussels were cleaned and placed into the cages and oyster shells were placed in the baskets as substrates for mussels. The cages were closed at all sides by net. Then the seeded cages were tied with nylon ropes and suspended in the water column from the rack with the bottom of the baskets about 1 m above the sea bed.

For rack hanging culture, size ranges from about 35 mm to 70 mm *P. viridis* were used. The mussels were collected from their natural beds in the subtidal area of Ye River Mouth with the help of local mussel collector. Coir ropes were made by using polyethylene ropes (about 4 cm in diameter) and coconut fibre ropes (about 2cm in diameter). The coconut fibre ropes (1.5 ft) were twisted around the polyethylene ropes (3ft) and tied at both ends (Fig. 6C). The collected mussels were cleaned and inserted among coconut fibres on the 1 m length polyethylene-coconut coir ropes so that they cannot slip off before their byssal threads attached on the rope. Each seeded rope was put into the cylindrically stitched bag of nylon net and both the ends of the bags were stitched to the rope. The seeded ropes were suspended in the water column from a wooden pole frame in such a way that the bottom oyster shells did not touch the muddy bottom. The experimental rack culture in Sitaw was carried out in one day after collecting the mussels in order to minimize any possible disadvantages and cultured seed may have a better adaptation on the rack. Monthly observations were made to study growth rate, nature of fouling on growing mussels and spat settlement on ropes.

3.8 Long-line culture at Shwekyungyi (Russell Island)

After rearing 39 days period in the laboratory, two collectors attached with mussel spats were tied to each circular net (Fig. 6D&6E). The circular nets with two collectors were hung on the long line system for grow out culture. (Fig. 6F), that is out of the laboratory to the field. The nets were soaked in fresh water for removing other fouling organisms twenty days after growing in the field (Fig. 6G). Monthly sample was collected from grow out culture to determine the growth length, height and weight of the mussels.

Figure 6 A-G. Grow out culture of *Perna viridis* at Sitaw (**A-C**) and at Shwekyungyi (Russell Island) (**D-G**): **A**) Rack for experimental grow out culture; **B**) Young mussels on the rocky shore; **C**) Polyethylene ropes and coconut fiber ropes for mussel seeding; **D**) Attaching the spat collectors in the circular nets; **E**) Circular nets with two spat collectors for grow out culture; **F**) Long line for grow out culture; **G**) Soaking the nets in fresh water to remove other fouling organisms.

3.9 Data Analysis for growth rate

Larval rearing data recorded in the laboratory culture at Shwekyungyi (Russell Island) was analyzed at 5% level of significance. ANOVA was used to compare the amount of mussel larvae survival and growth rate in the different treatments of antibiotics. If significant and the variances showed to be homogeneous, average analysis according to Tukey test was applied using SPSS software program. For the other results, only descriptive statistical analysis was done.

For the analysis on growth rate of *P. viridis* cultured at Ye estuary, the shell length of each specimen was monthly measured to the nearest 0.01 mm with Vernier Calipers and each sample was divided into 8 mm length classes. As no sexual dimorphism could be discerned externally, no effort was made to study the growth related to sex. The data were analyzed using FiSAT II software by length-frequency data analysis (Gayanilo *et al*., 1996). The growth was calculated from the mean monthly length of the shell attained by the animal (Ford, 1933).

Asymptotic length (L_∞) and growth co-efficient (k) of the von Bertalanffy Growth Formula (VBGF) were estimated by means of ELEFAN-1 (Pauly and David, 1981). The emphirical growth curve was fitted to the total length data using the von Bertalanffy's growth equation: $\mathbf{L_t = L_\infty\ [1\text{-}e^{-k(t\text{-}t_0)}]}$ where, L_t = length at time 't'; L_∞= length at infinity (asymptotic length); e = base of the natural logarithm; k = growth coefficient; t = time of observation; and t_0 = arbitrary origin of growth.

The growth coefficient (k) was estimated by the least square method following Bal and Rao (1994) as b=e* where b is the slope of the equation $l_t = 1 = a + bl_t$, and 'e' is the base of natural logarithm. Monthly specific growth rates of *P. viridis* were calculated from the mean monthly length attained by the animal according to the formula of Bal and Jones (1960):

$$G = \frac{(\mathrm{Log_e}\ L_2 - \mathrm{Log_e}\ L_1)}{T_2 - T_1} \times 100$$

Where, Log_e = natural logarithm, L_2 and L_1 = the shell length at time T_2 and T_1 respectively and the growth was expressed in percentage per month.

To determine the survival rate of mussels, every individual of each cage and each string in Sitaw and each net in Shwekyungyi (Russell Island) were counted for the number of alive mussel. Any mussel having its valve open or having the smell of decomposition was treated as a dead one. The survival of each cage and each string in each sampling was expressed in percentage and was calculated using the formula: $S=n/N \times 100$**.** Where, S= the survival rate (%) for each sampling, n = the number survived for each sampling and N = the initial number stocking. Finally, at the close of experiment, the entire stock of mussels was collected and survival rates (%) were computed from the initial and final data.

Results

4.1 Allometric and length-weight relationship of *Perna viridis*

The length of collected mussels ranged from 65 to 163 mm, the height varied from 31 to 61 mm; the total weight from 12 g to 236 g; tissue wet weight from 7 to 63 g and shell wet weight from 12 to 119 g. During the study, maximum shell length and total weight for the combined sexes were 163 mm and 207 g, respectively. Sex was determinable for all specimens. Out of 100 collected specimens, 60 were males and 40 were females. In this study, 1:0.67 male to female sex ratio was significantly different from the 1:1 ratio. All length-weight relationships shows non-linear pattern and did not show any significant difference between males and females. The correlation coefficient (r) values obtained for shell length and total weight indicate that a significant and high degree of positive correlation exist between shell length and total weight of this species. In the present study 'b' value for all the allometric relationships for length-weight, height-weight and width weight were found to be less than '3', except for the 'b' values for height- shell wet weight for male, height-total weight, height-shell wet weight for females mussels and height-shell wet weight for combined sex. This result indicated that there is a significant variation in the growth rate

4.2 Gonadal development and sex ratio of *Perna viridis*

From the histological preparations, four main stages were distinguished in the reproductive cycle of *P. viridis* (Fig. 7). In the case of males and females, developing gonads (Stage I) were encountered in November and December. Ripe gonads were in good numbers from January and March, while partially spawned (Stage III) males were found in good numbers from April to August. Spent and spent resorbtive individuals (Stage IV) were predominant from September to October. However partially spawned mussels were observed in almost all the months and again in July, while spawning females were recorded from October to April and again in July. Spawning of *P. viridis* took place the extended period of time in Sitaw since spawning and partially spent specimens of both the sexes were recorded from April to October. An important factor noted during the course of the study was that there was only stray spatfall on the rocky shore of Sitaw and no appreciable spatfall takes place to establish a natural population within the area. However, mussels can be exploited from the submerged natural bed under about 10 meters all year round. Males were dominant in 11 of 12 months observed in the mussel population and significantly different from 1:1 sex ratio. Sex composition in different length groups, indicates that both males and females are almost equally distributed in all the size groups except in the large groups of 101- 110 mm

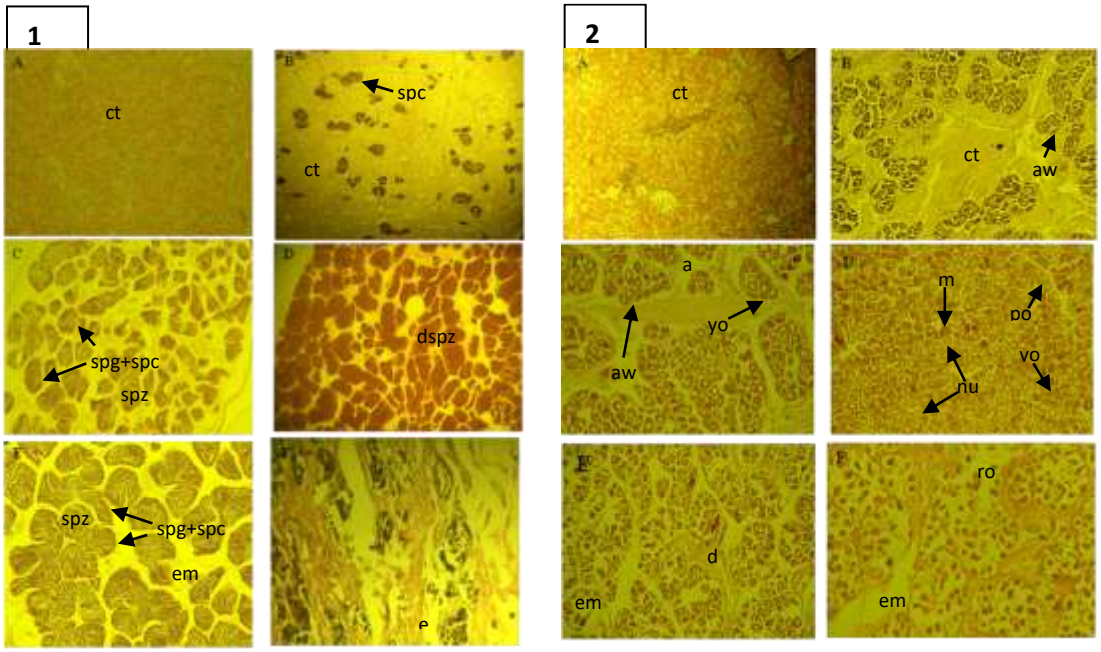

Figure 7 1A-2F. Photomicrographs of male gonads (**1A-1F**) and female gonads (**2A-2F**) at different stages in sexual cycle of *Perna viridis* (10 x). **A-C**) indicate developing/re-developing stages; **D**) shows ripe gonads; **E**) shows spawning in progress and **F**) shows spent/resting gonads. (Abbreviations used: ct: connective tissue; dspz: dense spermatozoa; em: empty acinus; spz: spermatozoa; spg: spermatogonia; spc: spermatocytes; a: acinus; aw: acinus wall; d: duct; em: empty acinus; mo: mature oocyte; po: polygonial oocyte; ro: resorbing oocyte; yo: young oocyte)**.**

4.3 Condition index

Variations in the value of condition index (CI) was studied by two methods; percentage of meat weight in shell weight of the mussel (CI_{shwt}) and meat weight in total weight of the mussel ($CI_{commercial}$). CI was higher in pre-monsoon and early monsoon and low in late monsoon and post monsoon seasons. The overall condition index was found to be high during the monsoon period (Table 1). Condition Index ($CI_{commercial}$) ranged from 25.61% in July to 37.32% in June (Fig. 8A). Distinct peaks in percentage edibility ($CI_{commercial}$) were observed in June and October. Generally, percentage edibility of mussels was low in December to July and high in June and August to September months. Highest index (CI_{shwt}) was recorded in June and the lowest in July 2017. Subsequent to a peak $CI_{commercial}$ (1.24 and 1.20) in June and October, a decrease was observed in May (0.88) and in July (0.82). CI (CI_{shwt}) displayed continuous decline from March to May which later improved in August (Fig. 8B). Meat yield or percentage edibility ($CI_{commercial}$) also displayed similar patterns as CI_{shwt} in Sitaw mussels.

Table 1 Seasonal variation in the condition index and edibility of green mussels.

	Condition Index	**Edibility**
Premonsoon (February – May)	0.9800	0.9450
Monsoon (June – September)	1.0225	1.0280
Post monsoon (October – January)	0.9875	0.9900

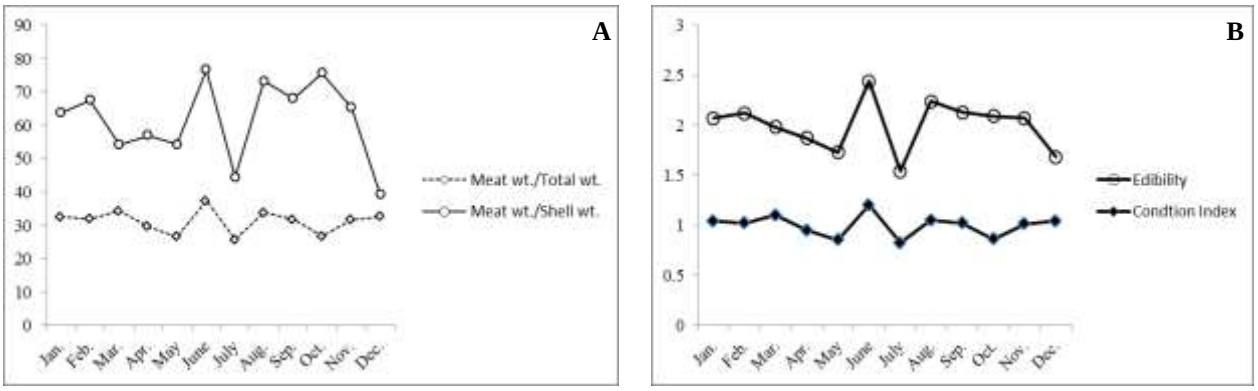

Figure 8 A&B. A) Index of condition (%); **B**) CI ratio = $\bar{x}CI_{month} / (\bar{x}CI_{all\ month})$. Based on the values obtained, the monthly CI which exceeded its annual mean was classified as "high (CI ratio >1)" and the remaining as "low (CI ratio <1)" (Hickman *et al.*, 19910).

4.4 Experimental hatchery of *Perna viridis* at Shwekyungyi (Russell Island)

4.4.1 Spawning, fertilization and developmental stages

Spawning took place after 2 hours of thermal stimulation and thermal increase from 18°C to 30°C. The male mussels released sperms first as a smoky stream (Fig. 9A) and females released millions of orange colored eggs (Fig. 9B). About 394,600,000 fertilized eggs were obtained from spawning, of which 361, 153, 410 resulted in D-hinge larvae about 16-20 hours after fertilization, representing a 90% yield in this phase of the hatchery. Of these only 900,000 were used for triplication in five experiments (one control and four antibiotic treatments) to observe the effect of antibiotics on the development and survival of the larvae. The different stages of egg development to young mussel are shown in figure 9C-9R.

Different larval stages of *P.viridis* larvae in five experiments during 18 days rearing period was shown in table. Of these five culture experiments, only two experiments treated with a mixture of penicillin and streptomycin (T3) and chloramphenicol (T4) succeeded to develop to the pediveligers stage. Chloramphenicol is totally banned for use in aquaculture and can be used only for research purpose (DOF, 2011; ASEAN, 2013). Benzylpenicillin and streptomycin are allowed chemicals to use in aquaculture (DOF, 2011). T3 larvae, therefore, were then transferred to the settlement tanks hung with collectors two days after 90 percent of larvae were with eye spots as well as the larvae were still actively free-swimming.

The larval stage typically last 3 weeks and the larvae grew to a shell length between 300-400 µm. At this point they are referred to as eye-spot larvae (pediveligers) because they have developed an ‘eye-spot’, and a ‘foot’ in addition to the velum (Fig. 9R). Larvae at this stage were capable of swimming with the velar cilia as well as crawling with the foot. The velum was reduced in size and is replaced by buds that will later form the gills (Fig. 9S). The average shell length was 332.83± 10.34 µm (300-400 µm) on day 18. The larvae have now transformed from the free swimming pelagic larvae to the creeping, crawling benthic stage ready to attach to the substratum.

The pediveliger settle on the substratum at the end of the crawling stage and become plantigrade. On day 21, the larvae began its sessile life and spat settlement could be observed from 21st day onwards. The larva measured 400–490 µm in the anteroposterior axis and 380-470 µm in the dorsoventral axis. At plantigrade stage, the velum almost disappeared, labial palps appeared and additional gill filaments appeared. The plantigrade measured 480 × 460 µm on day 23, 910×460 µm on day 28.

The plantigrade transformed into young spat by developing the characteristic of miniature adult shell. The shell by now was typically oblong shaped like the adult mussel. The concentric growth lines, foot, heart, mantle edge, visceral mass and intestine can be distinctly seen in figure 9T.

The spat attached to the collectors by secreting the byssus threads (Fig. 9U) and exhalent and inhalant siphon extruding were also observed (Fig. 9V). Spatfall or settlement began on day 21 and continued up to day 39. Spat measured 510×390 µm on 21st day and 1100 × 790 µm on 39th day (Fig. 9T). Significant mortality of spat settled on the tank bottom was observed during the collecting period. In this experiment T3 had 23.50 ± 9.89 % survival and the highest recovery rate. A total of 14,100 mussels were counted in this treatment, of which 21.45 % (3,025 spat) were found on the collectors and 78.55 % on the bottom of the tank as dead mussels.

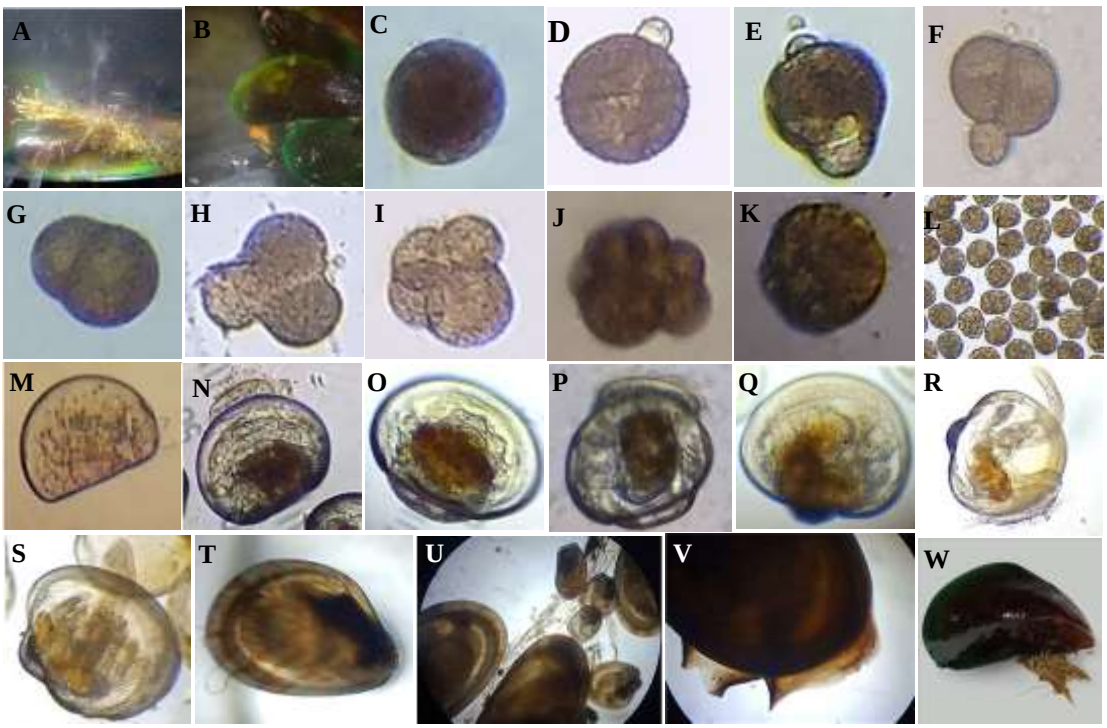

Figure 9 A-W. Spawning,Fertilization and development of mussel embryos **A**) Male green mussel releasing white clouds of sperms; **B**) Female green mussel releasing orange eggs.: **C)** fertilized egg (50µm) and sperm (arrow); **D)** fertilized egg with first polar bodies developing ; **E)** Extrusion of the first and second polar bodies ; **F)** First cleavaged egg showing the "trilobed" appearance ; **G)** two celled stage ; **H)** Formation of the second polar ; **I)** second cleavaged and formation of 4-celled stage; **J)** 8-celled stage; **K and L)** ciliated gastula stage (60µm); **M)** D-hinge stage; **N**) Early umbo showing overall organogenesis and microalgae (brown pigmentation) content in stomach (5 d); **O**) late umbo (7d); **P**) umbonate (9d); **Q**) Eye-spot stage larvae (13 d); **R**) Pediveliger larvae with developed foot (18 d); **S**) Plantigradelarvae with distinct eye-spot, buds and foot, exploring (28 d); **T**) Metamorphosed mussel spat with a bysus and many gill filaments (39 d); **U**) Spats with bysus threads (39 d); **V**) Spat with exhalent and inhalant siphons, exploring (39 d); **W**) Young mussel (3months).

Table 2 Different larval stages of *Perna viridis* in days (d).

Stage	P	S	PS	Chlo.	Cont.
D	3 d	3 d	3 d	3 d	3 d
EU	6 d	6 d	5 d	6 d	7 d
LU	-	9 d	7 d	8 d	11 d
U	-	17 d	9 d	10 d	-
E	-	-	13 d	14 d	-
PV	-	-	18 d	-	-

P=penicillin, S=streptomycin, PS=a mixture of penicillin and streptomycin, Chlo.=chloremphenicol, Cont.=control, D=D stage, EU= early umbo, LU= late umbo, U= umbonate, E= eye-spot, PV= pediveliger, d=day.

4.4.2 Growth and survival rate of mussel larvae

The growth of shell length and the survivality of mussel larvae during 18 days larval rearing period are shown in figure 10 and 11. Average shell length measurements among control and treatment larvae over 18-day rearing period were significantly different (ANOVA; $F_{4, 57} = 5.72$, $p=0.001<0.05$). Average shell lengths in the larvae treatment with a mixture of penicillin and streptomycin were significantly different to the other treatments ($p< 0.001$). However, T3 and T4 larvae were not significantly different during 18 days period ($p = 0.684>0.05$).

The average daily shell length growth was 13.91 µm, 16.69 µm, 7.31 µm, and 7.88 µm in T1, T3, T4 and T5, respectively. A regression analysis showed that T1, T3, T4 and T5 had the strong relationship between age (day) and shell length (R^2 = 0.918, 0.9886, 0.9777, 0.9259 respectively). T2 larvae had an average daily shell length growth of 9.01 µm with a good relationship between shell length and age ($R^2 = 0.7321$). The result showed that T3 larvae have the highest average daily shell length growth than other experiments.

The survivability (%) of larvae among antibiotic treatments and control was significantly different (ANOVA; $F_{4,57} = 4.96$, $p=0.02<0.05$). Average percent survival of T3 larvae was significantly different to the other larvae (Turkey test; $p=0.013< 0.05$) however, there was no significant (Turkey test; $p = 0.415>0.05$) difference in percent survival between T3 and T4 larvae.

4.5 Grow-out culture of *Perna viridis* at Shwekyungyi (Russell Island)

The spat were transferred to grow out site on day 39. Monthly specific growth rate and mean monthly length of *P. viridis* from long line culture were shown in table 3. As the length of *P. viridis* increased, the specific growth rate also decreased from 58.88 % to 5.20 % after five months in the field. Monthly growth length for nine month cultured in the open sea was 14.08 mm. Monthly growth lengths and shell morphology was shown in figure 13 A-F.

The result of survival rate of *P. viridis* at Shwekyungyi (Russell Island) was shown 35% survival of *P. viridis* was observed with 168 mussels survival out of 480 individuals after 9 months culturing periods. The minimum survival rates were observed in August 2018 (84.69%), January 2019 (83.54%) and February 2019 (84.85%). Regarding the survivability of green mussel a steep decline was observed from 92.27% in July 2018 to 84.69 % in August 2018. A gentler decline of the mussel survivability for the study period was observed from September 2018 to December 2018 (Fig. 12).

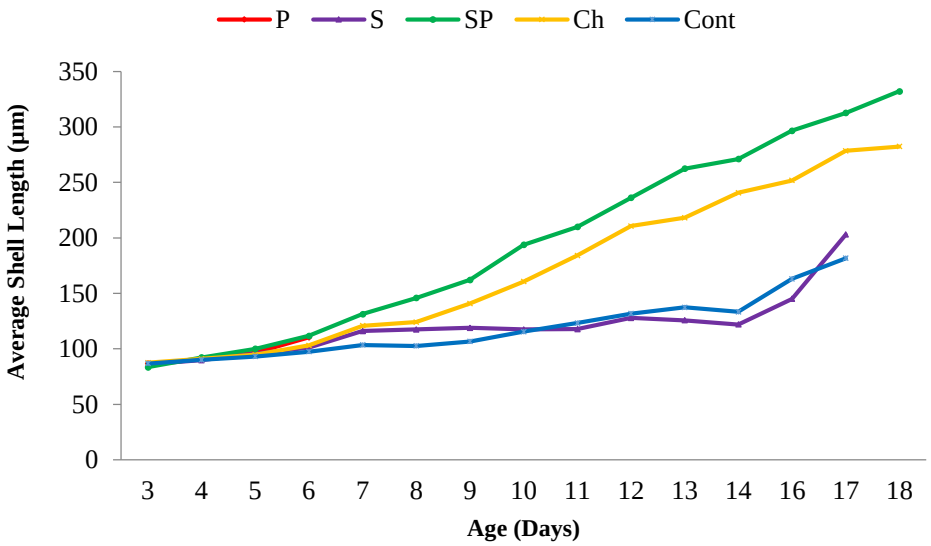

Figure 10 Average shell length of mussel larvae over 18-day rearing period when inoculated with different antibiotics. T1 larvae had high mortality at day 7; therefore shell length was not attainable.

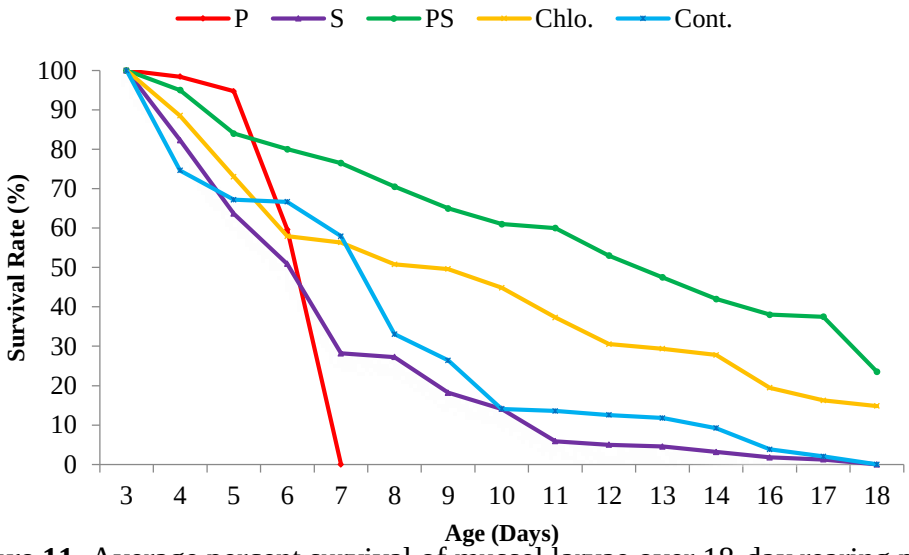

Figure 11 Average percent survival of mussel larvae over 18-day rearing period.

Table 3 Average observed length, growth increment and specific growth rate of *Perna viridis* at Shwekyungyi (Russell Island).

Month	Average observed length (mm) (Mean ±S.D.)	Growth increment (mm)	Specific growth rate (%)
Jun.'18	2.75 ± 1.94	-	**135.58**
Jul.'18	10.67 ± 1.88	7.92	35.45
Aug.'18	15. 21 ± 2.02	4.54	35.86.
Sept.'18	**21.77 ± 3.37**	**6.56**	**29.02**
Oct.'18	29.10 ± 4.92	7.33	19.06
Nov.'18	35.21 ± 6.34	6.11	15.78
Dec.'18	41.23 ± 7.32	6.02	13.57
Jan.'19	47.23 ± 8.31	6.00	11.98
Feb.'19	**53.24 ± 7.99**	**6.01**	-
Average		**6.31**	

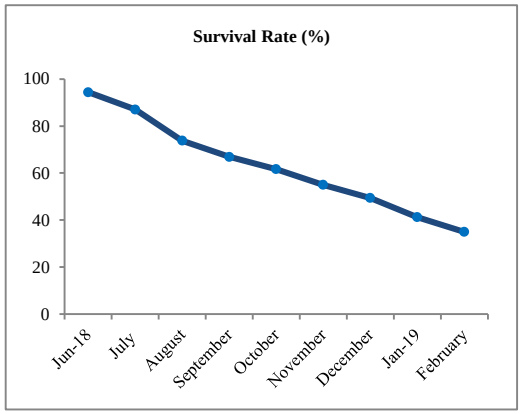

Figure 12 Monthly survival rate (%) of *Perna viridis* at Shwekyungyi.

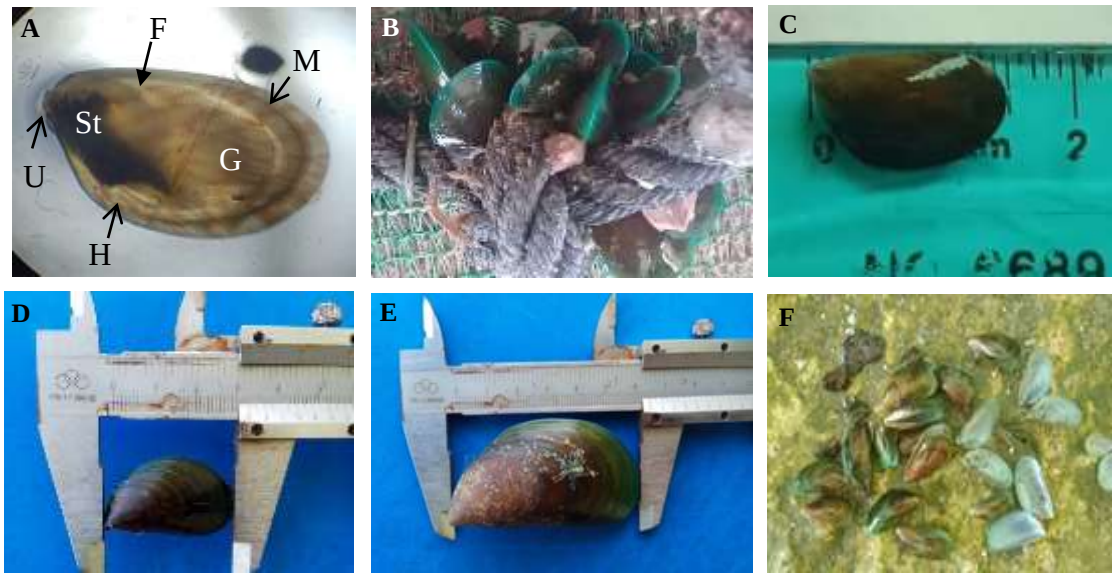

Figure 13 **A-F. *Perna viridis***: **A**) Spat after 39 days (2.75 mm); **B**) 2 months old mussel (10.54 mm); (**C**) 3 months old mussel (15.01 mm) ; **D**) 5 months old mussel; **E**) 9 months old mussel (62.35 mm); **F**) Dead green mussels observed in November 2018; (Abbreviations used: F: Foot, G: Gill, H: Heart, M: Mantle, St: Stomach, U: Umbo)

4.6 Rack culture of *Perna viridis* at Sitaw, Ye Estuary

4.6.1 Growth and survival

Monthly specific growth rate and mean monthly length of *Perna viridis* from two experiments (cage and rack-hanging method) were shown in table 4 and 5. The maximum specific growth (90.56%) of cage culture was observed in May, 2016 and the minimum in 2.54% in March, 2017. As the length of *P. viridis* increased, the specific growth rate also decreased from 90.56% to 2.54%. The maximum specific growth of rack-hanging method culture was found in January 2017 (12.86%) and the minimum (2.26%) was observed in July. The average growth rate of mussels in

the 8.64-10.99 mm size group seeded on cages was observed to be about 9.22 mm while those of size group 35-70 mm seeded on ropes showed an average growth of 4.89 mm in the initial 5 months (Table 4&5). The average growth rate of mussels in the 8.64-10.99 mm size group seeded on cages in a year was observed to be about 5.65 mm while those of size group 35-70 mm seeded on ropes showed an average growth of 4.89 mm in the later months.

From the result of experimental grow out culture of mussel in Sitaw, Ye estuary, only one dead mussel was observed from 60 seeded mussels in cages in August. Therefore, 98.33% survival rate was observed in October and 100% survival was investigated in the other months. 100 % survival rate in the rack-hanging method was recorded in the months of January to May 2017 and from September to October 2017. But the survival rate was 98% in July and 99% during the months of July and August. There were no statistical differences among the study, although mussels in the months of June, July and August had the mortality of one mussel each in rack-hanging ropes. The growing mussels from rack culture were shown in figure 14 A-C. Young mussels (about 10 mm in length) were observed on the shells of cultured adult mussels on April 2017 (Fig. 14C).

Table 4 Average observed length, growth increment, specific growth rate and the length as determined by the von Bertalanffy's growth equation of *Perna viridis* (cage culture).

Month	Average observed length (mm) (Mean ±S.D.)	Growth increment (mm)	Specific growth rate (%)	Length determined by growth equation $L_t = L_\infty[1-e^{-k(t-t_0)}]$
May. 2016	8.64±0.73	-	90.56	14.26
Jun.	21.37±1.94	11.37	37.76	25.14
Jul.	31.17±1.88	9.80	25.36	34.91
Aug.	40.17±2.02	9.00	19.40	43.66
Sept.	48.77±3.37	8.60	14.00	51.52
Oct.	56.10±4.92	7.33	13.38	58.58
Nov.	64.13±6.34	8.03	8.47	64.91
Dec.	69.80±7.81	5.67	8.03	70.59
Jan. 2017	75.63±8.85	5.83	7.96	75.69
Feb.	81.90±10.55	6.27	6.92	80.26
Mar.	87.77±11.55	5.87	2.54	84.36
Apr.	90.03±11.46	2.26	_	88.05

Table 5 Average observed length, growth increment, specific growth rate and the length as determined by the von Bertalanffy's growth equation of *Perna viridis* (rack hanging method).

Month	Average observed length (mm) (Mean ±S.D.)	Growth increment (mm)	Specific growth rate (%)	Length determined by growth equation $L_t = L_\infty[1-e^{-k(t-t_0)}]$
Jan.2017	51.79±12.13	-	12.86	5.94
Feb.	58.90±12.45	7.11	8.94	10.50
Mar.	64.41±12.20	5.51	4.89	14.89
Apr.	67.64±12.59	4.23	4.53	19.10
May	70.87±12.78	3.23	6.11	23.14
Jun.	75.24±12.49	4.37	3.28	27.04
Jul.	77.75±13.27	2.51	2.26	30.77
Aug.	79.53±13.88	1.78	2.33	37.36
Sept.	81.40±14.41	1.87	3.25	37.81
Oct.	84.09±14.64	2.69	_	41.12

Figure 14 A-C. Experimental grow out culture at Sitaw: A) Seeded cage with growing mussels; **B**) Seeded rope with adult mussel; **C)** Young mussels on adult mussels.

4.6.2 Population parameters

The values estimated for the parameters of the von Bertalanffy's growth equation are shown in table 6. Substituting these values in the von Bertalanffy's growth equation, the equations for cage and rack-hanging culture could be expressed as: $L_t=120.23[1-e^{-1.3(t+0.01381)}$) and $L_t=122.33$ $[1-e^{-0.48(t+0.02031)}$) respectively. The theoretical growth curves of cage and rack-hanging cultures are presented in figure 15 and 16. From this growth curve, it can be observed from the cage culture that animal attains a length of 88.05 mm, 111.46 mm, and 117.84 mm at the age of 1, 2 and 3 years, respectively and 47.37 mm, 75.95 mm and 93.63 mm at the age of 1, 2 and 3 years, respectively, from the rack-hanging method. Growth co-efficient (k) was 1.3 yr^{-1} for *P. viridis* in cages and 0.48 yr^{-1} in rack-hanging ropes (Table 6 and Fig. 15&16).The computed growth curve with these parameters has been shown over the restructured length distribution in figure 15 and 16.

Table 6 Values estimated for the parameters of the von Bertalanffy's growth equation.

Method	Asymptotic length (L_∞)	growth coefficient (k)	arbitrary origin of growth (t_0)
Cage	120.23 mm	1.3	-0.01381
Rack-hanging	122.33 mm	0.48	-0.02031

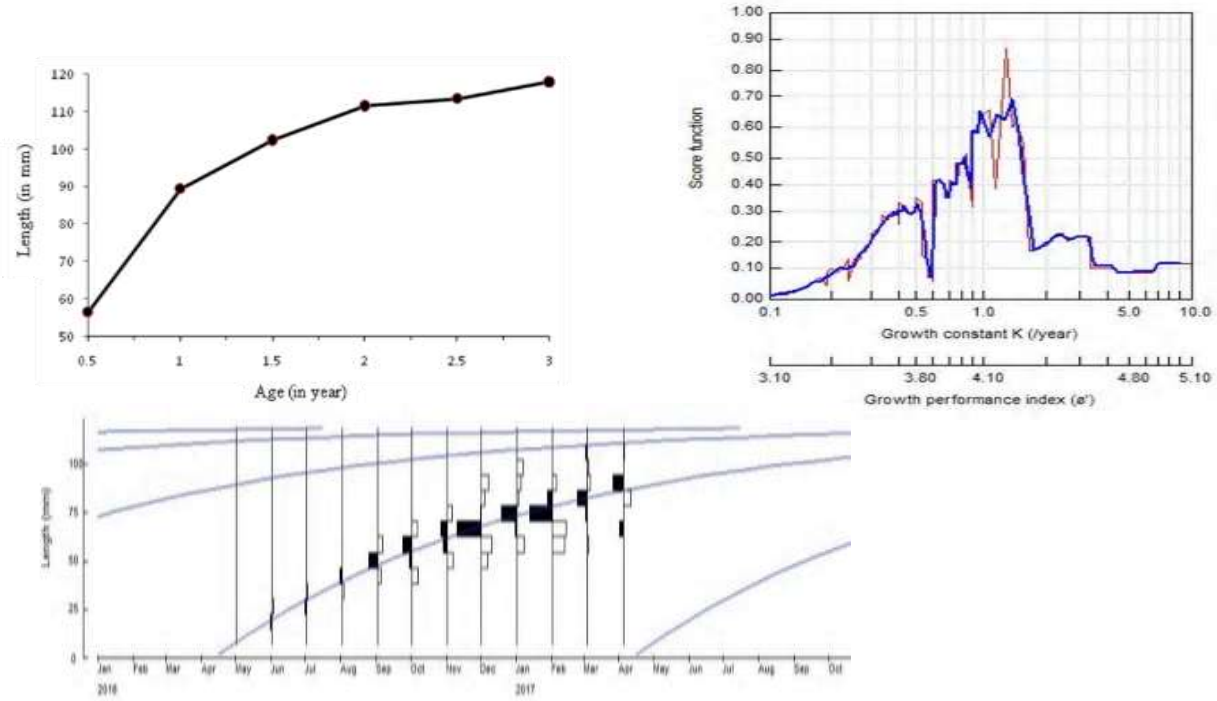

Figure 15 Theoretical growth curve of *Perna viridis* (cage culture) and Von Bertalanffy's growth curves (L_∞= 120.23mm and k= 1.3 year^{-1} for *Perna viridis* (cage culture) superimposed on restructured length-frequency histograms.

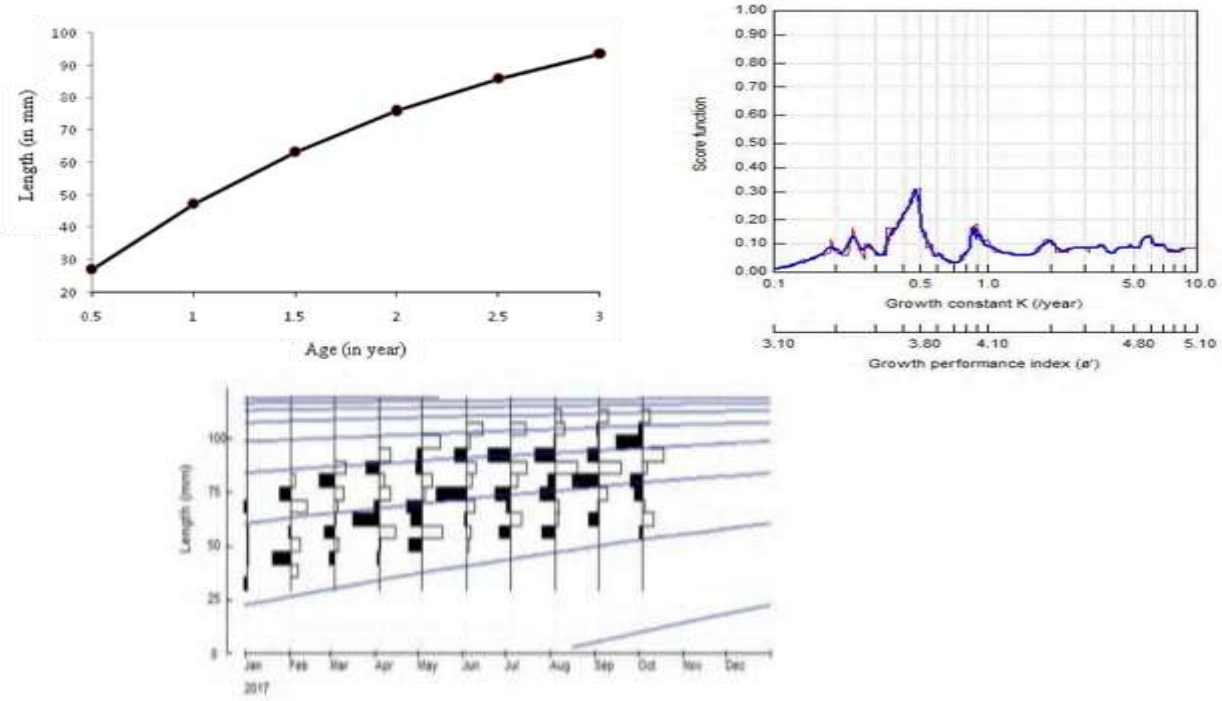

Figure 16 Theoretical growth curve of *Perna viridis* (rack-hanging culture) and Von Bertalanffy's growth curves (L_∞= 122.33mm and k= 0.48 year^{-1} for *Perna viridis* (rack-hanging) superimposed on restructured length-frequency histograms. Black and white bars = positive and negative deviation from 'weighted' moving average of length classes. Number of sample = 60 individuals.

4.7 Biofoulings

The fouling of cages, nets and rack materials in the culture area was a serious problem during the culture period. Very often, heavy settlement of barnacles was observed on the rack materials within a period of 30 days after experiment. At Sitaw**,** the fouling organisms such as shrimps, young fish, oysters, gastropods of *Littorina sp*, barnacles (*Balanus sp*), *Saccostrea sp*, polychaetes, amphipods, and isopods were found on the rack and on the cage. Interestingly, only few barnacles, gastropods and oysters were observed on the mussels shell and in the cages. The growth of the barnacles over the oyster shells, on the rack and cage was very rapid. The settlement of barnacle larvae was observed to continue during the entire study period. The accumulation of silt on the mussels was observed every month. Therefore, the periodical cleaning of the mussel and culture materials were necessitated.

At Shwekyungyi (Russel Island), a diverse range of biofouling organisms accumulated on green mussel culture ropes and on the nets. Biofouling organisms such as sessile taxa (algae, sponges, hydroids, anemones, bivalves, bryozoans, tubeworms and ascidians) and mobile taxa (flatworms, polychaete worms, amphipods, isopods, crabs, shrimps, and fish) were observed in the culture area. Biofouling organisms variously occupied vacant space on mussel ropes as well as grew epibiotically on mussels and other biofouling. Sponges and hydroid were found on the net during earlier culture period. Barnacles were observed on the shell of growing young mussels and on the collecting ropes. Hydoids and red seaweeds were densely observed on the line of green mussel crops. Regular inspection and regular clearing y bioforeling organisms were undertaken.

Discussion

During the present study, the slope (b) of the allometric relationship values ranged from 2.4 to 3.64 and most of 'b' values were lower than 3. The present results agreed with the findings of length-weight relationship of *Perna viridis* by the earlier workers (Narasimham, 1981; Lee, 1985; Sharma *et al.*, 2005; Soumady, 2012; Sushant & Sujit, 2014; Thejasvi *et al*., 2014). However, the exponential value (b) for the relationship total length and weight of male and female *P. viridis* was higher than the results (1.4117 and 1.4385) of Soumady (2012). Ricker (1958) stated that intra and inter specific comparison of growth can be made using the slope or exponent of the length-weight equation, which typically lies between 2.5 and 4.0 for most animals.

The values of 'b' in the relationship of height-shell wet weight for male, height-total weight, height-shell wet weight for females mussels and height-shell wet weight for combined sex was higher than 3 and showed that the relationship between certain shell height and weight of *P. viridis* was positive allometric in females. Soumady (2012) also presented the positive relationship between length-weight, length-shell weight, length-total tissue weight (immature, male and female), length-height, length-width (immature). Generally, positive allometric relationships have been reported in bivalves. This might partly be explained through the influence of ecological factors such as mussel density, shore level etc. Such ecological differences were demonstrated by Hickman (1979) who compared wild stocks and raft-grown populations of *P. canaliculus*.

The coefficient of correlation 'r' values obtained for the total length and weight, height and weight, and width and weight of male, female and combined sex of *P. viridis* is more than 0.60, which indicates that a significant and high degree of positive correlation is between total length and weight of this species. Similar relationship was reported in the earlier study in *P. viridis* (Sharma *et al*., 2005; Soumady, 2012).

Sexes of *P. viridis* in the present study area were mature when the body length reached about 30 mm. A study by Narasimham (1980) reported mature gonads in this species above 28 mm. Tuaycharoen *et al*., (1988) also observed that mature gonads were found 21.3 mm in length in female *P. viridis* and 23.0 mm in length in male *P. viridis*. Males were dominant all months observed in the mussel population and sex ratio (1: 0.67 & 1: 0.54) was significantly different from 1:1sex ratio. Sex composition in different length groups, indicates that both males and females are almost equally distributed in all the size groups except in the large groups of 101- 110 mm. Al-Barwani *et al*., (2011) observed the overall sex ratio 1:1 of *P. viridis* in Malaysia with female significant dominance in some months while male have shown some significant dominance over the females.

From the histological examination of gonads, partially spawned (Stage III) mussels were found all year round and in good numbers were observed in June and July. This means that *P. viridis* has the extended spawning period. Narasirnham (1980) and Tuaycharoen *et al*., (1988) also reported that the green mussel spawning season was prolonged. The peak reproductive activity coincided with rising in temperature and salinity in March and April 2016 and 2017. Nagabhushanam and Mane (1975), Rajagopal *et al.*, (1998a), Narasimham (1980), Ajithakumar (1984), Parulekar *et al.*, (1982) also indicated that peak reproductive activity of *P. viridis* coincided with rising water temperature as well as with increase in salinity. Rao (1951) also reported that the reproductive cycles of many marine bivalves have been correlated with salinity fluctuations in tropical region.

The lowest CI and edibility of green mussels in July was may be due to peak spawning of mussels. Wet meat percentage or percentage edibility also followed similar trends as CI, with highest meat percentage in March prior to spawning. Peak spawning of this species at Ye estuary took place in May-July after rising in salinity and temperature in April. After that CI value decreased sharply subsequent to after spawning. The range of wet meat percentage observed in the study was comparable with the observations of Narasimham (1980) from natural beds and with the observations of Rivonker *et al.*, (1993a), Rajagopal *et al*., (1998b) and Mohamed *et al.*, (2010) from suspended culture of *P. viridis* along the Indian coast.

The highest CI and edibility was observed in monsoon seasons followed by post monsoon and premonsoon. This means that the CI ratio was high during the monsoon seasons although spawning of mussels took place in this season. During the high CI ratio in monsoon season, the mean surface seawater salinity was decreased from 21.50 ‰ in May to 4.82 ‰ in June 2016 and from 23.28 ‰ in May to 6.38 ‰ in June 2017. Hickman *et al.*, (1991) correlated reduced salinity with improved mussel condition index, higher nutrient levels, higher chlorophyll a and larger quantities of particulates in *Perna canaliculus* in New Zealand. The percentage edibility or wet meat percentage of *P. viridis* were related to variations in environmental parameters (Parulekar *et al.*, 1982; Rivonker *et al.*, 1993b and Mohamed *et al.*, 2010).

The natural spat settlement on the intertidal rocky shore observed in the previous study cannot support the green mussel culture. Therefore the hatchery production of mussel seeds in the laboratory was carried at Shwekyungyi (Russell Island). Induced spawning of bivalves is dependent on the availability of broodstock with mature gonads in ripe condition. It is important to determine the spawning cycle of broodstock for induce spawning (Sahavacharin *et al*., 1988). In the present study, the broodstock were collected before peak spawning seasons (June-August) and spawning was induced by thermal stimulation from 18- 32ºC. The varying degrees of temperature can effect on the gonadal maturity and high seawater temperature can also effect on

the efficiency in induce spawning of *Perna viridis* (FGIS, 2005; Sreedevi *et al*., 2014; Soon and Ransangan, 2014).

The embryonic development of *P. viridis* has a similar development compared to the previously studied bivalves by several workers (Aquacop & Cnexo-cop, 1979; Sreenivasan *et al*., 1988; CMFRI, 2006; Da Costa *et al*., 2008; Beduschi *et al*., 2009; Aarab *et al*., 2013; Kamermans *et al*., 2013; Hanyu *et al*., 2016; Anil *et al*., 2017; Ompi and Svane, 2018) although it was slightly faster than their results. The timing of developmental stages varies with different temperature, different species and different habitats.

Feeding the bivalve larvae is a major constraint in the hatcheries. The use of monospecific diets in the feeding stage are not beneficial for bivalve larvae while mixed diets have a positive effect on growth and mortality compared to diets consisting of only one algal species. The naked flagellates *Isochrysis galbana* and *Monochrysis lutheri* have almost become the universal food for the early larval stages of most of the bivalves in rearing and *I. galbana* was commonly used to feed larvae of mollusks by several researchers (Aquacop, 1983; Robert *et al*., 2001; Aarab *et al*., 2013; Hanyu *et al*., 2016; Anil *et al*., 2017).

The larval stages of *Perna viridis* goes through similar larval stages as described for mollusks including *P. viridis* by Aquacop (1983), CMFRI (2006), Beduschi *et al*., (2009), Rusk (2012), Aarab *et al*., (2013), Kamermans *et al*., (2013), Hanyu *et al*., (2016), Anil *et al*., (2017). Large variations in the growth rate of larvae of the same batch were observed in *P. viridis* as has been reported in several other bivalves.

Antibiotics are commonly used in the world used to avoid the adverse effect of pathogens in aquaculture (Spencer, 1952; Benbrook, 2002; EC (2002 a, b); Campa-Córdova *et al*., 2005; Serrano, 2005; Defoirdt *et al*., 2007; DOF, 2011; ASEAN, 2013; FAO, 2017). In the present study, the larvae treated with a mixture of penicillin/streptomycin (T3) showed highest larval development, survival rate and growth rate in five experiments. Average shell lengths and percent survival of T3 larvae were significantly different to the other treatments. These finding agreed with the result of Anguiano-beltra'n & Searcy-Bernal (2007) and Kesarcodi-Watason (2009) although the concentration was less than those of their studies. Benzylpenicillin and streptomycin are allowed chemicals to use in aquaculture (DOF, 2011). Combinations of antibiotics such as penicillin and streptomycin have been widely used in cultivation with positive survival and growth results in the species of interest (Banrie, 2013). The synergist effect of combining drugs of different groups depends on the degree of sensitivity of the micro-organism to these antibiotics.

In the present observations, green mussels attained the marketable size 64.13 mm within 6 months of cage culture period at Sitaw. However, the mussels reached 53.24 mm after 9 months of culture period at Shwekyungyi. The growth increment and the specific growth rate of *P. viridis* were faster at the early age than in the later stages. The decrease in growth rate and specific growth rate was observed with increase in shell length. These results agreed with the findings of Hickman (1979), Kamal and Khan (1998), Celik *et al*., (2009) and Awan *et al*., (2012) for *P. viridis*. The reason for this reduced growth rate may be the reduction in metabolic activity with age, which accounts for decreased growth rate as seen from reduction in specific growth rate. Soon and Ransangan (2014) also stated that internal energy reserves are consumed while the shell may continue to grow during spawning or food shortage.

The mean monthly length of *P. viridis* suggested that in cage culture, the animal attained a length of 90.03 mm in a year and the growth rate was 7.40 mm/month. On hanging culture, the mussel attained a length of 84.09 mm in 10 months and the growth rate was 3.23 mm/month. The

monthly growth rate of 7.2 mm, 7mm, 6mm and 5mm was observed by Sreenivasan *et al*., (1989), Paul (1942), Rao *et al*., (1975), and Qasim *et al*., (1977), respectively, for *P.viridis* by the end of the first year, from Indian natural environments. Kamal and Khan (1998) reported that the growth of green mussels inhabiting the Moheshkhali jetty, Bangladesh attained a length of 88.12 mm in a year and the growth rate was 7.34 mm/month. This comparison reveals that the growth of *P.viridis* cultured in Sitaw waters grows faster than those inhabiting Indian waters and Bangladesh waters. In the present investigation, mussels (cage culture) attained 64.13 mm within 6 month's and this result showed the potentiality of the present study site as a culture ground.

The comparison of von Bertalanffy growth parameters in *Perna viridis* from different habitats showed that the present L_∞ values of *P. viridis* from Sitaw were closed to the result of Myo Nandar Myint (2014), Taib *et al*., (2016) and Kassim *et al*., (2017) and lower than the results of Hemachandra *et al*., 2017 and Khan *et al*., (2010). The low L_∞ values of *P.viridis* in Malaysia might be the result of using data on narrower ranges of growth of the species. The coefficient 'k' can be used to compare between the growth of related species or same species in varied habitats. The k values of *P. viridis* in the present study were closed to the k value from Coastal water of Malacca, Peninsular Malaysia Coastal region. The 'k' value of *P.viridis* from rack-hanging culture at Sitaw waters was closed to the value of *P. viridis* from the intertidal region of Coconut Island of St. Mary's group of Islands off Malpe, India observed by Hemachandra *et al*., 2017 (Table 7).

The value of k (1.3 yr^{-1}) for cage culture in Sitaw waters is higher than values reported from Indian waters, Malaysia (Southern Malacca Straits) and Myeik waters (Myanmar). Interestingly, this value is similar to *P.viridis* of offshore waters of Naf River Coast, Bangladesh. Since k denotes the rate at which the growth decreases to reach the asymptotic, higher values of k denotes faster rates of growth (Joseph and Joseph, 1988). Thus the rate of growth reported in the present study is faster than that reported for the same species from Indian waters and Myeik waters (Myanmar) and more gradual than Coastal water of Malacca, Peninsular Malaysia. However the growth rate was the same with ffshore waters of Naf River Coast, Bangladesh.

Table 7 A comparison of von Bertalanffy growth parameters in *P. viridis* from different habitats.

Habitat	L_∞	k (yr^{-1})	Source
Intertidal region of Coconut Island of St. Mary's group of Islands off Malpe, India	136.9	0.42	Hemachandra *et al*., 2017
Offshore waters of Naf River Coast, Bangladesh	136.5	1.3	Khan *et al*., (2010)
Coastal region, Malacca, Malaysia	102.4	1.5	Al-Barwani *et al*., 2007
Maruda Bay, Northeast Malaysian Borneo, Malaysia	113.4	1.7	Taib *et al*., 2016
Southern Malacca Straits, Malaysia	120.75	0.66	Kassim *et al*., 2017
Myeik coastal waters, Myanmar	118.13	0.37	Myo Nandar Myint (2014)
Suspended plastic cage, Sitaw, Ye estuary, Myanmar	120.23	1.3	Present study
Rack-hanging, Sitaw, Ye estuary, Myanmar	122.33	0.48	Present study

The high survival rate of *P. viridis* at Ye estuary is may be due to the environmental conditions of the study site and because of the tolerance of this species. Mean monthly salinity at Sitaw ranged 4.82 ‰-31.40 ‰ in 2016 and 6.38 ‰- 30.50 ‰ in 2017. During monsoon seasons,

the mean salinity was 7.25‰ with the seawater surface salinity 0 ‰ in some days. The average salinity in Shwekyungyi showed stable salinity with a little fluctuation, however, the growth and survival rate of the cultured species was lower than that of in Ye estuary.

In estuarine conditions, the salinity levels built up gradually to open sea conditions from January to June but showed decrease in May due to heavy rains. Evidently, it is this less than ideal salinity and its fluctuations that lower growth rates of *Perna viridis* under estuarine areas. Notwithstanding this disadvantage in growth rates, estuaries are the preferred locations for mussel farming as evident by the 250 estuarine mussel farms existing in India and Thailand (Mohamed *et al*., 2003; Prakoon *et al*., 2010). Earlier studies have shown that this estuary is highly productive and thereby leading to improved feeding conditions. In addition, brackish water areas are more suitable for mussel culture as the mussels are euryhaline and can thrive well in such systems.

Anil *et al*., (2017) observed the highest survival rate because they reared spat in nursery-cages before seeding nursery ropes for further growth. They transferred the spat to ropes after 45-60 days of rearing in micron meshed cages. In the present study, the spats were transferred to long line system of grow-out culture at Shwekyungyi on 39th day. The lower survival rate of young mussels and monthly observed dead mussel shells may be due to the early transfer of spat from the laboratory to the grow out place.

During this study, the final survival of green mussels in the cages at Sitaw, Ye estuary was found to be better than that of mussels in the net of long line culture at Shwekyungyi. Jakate *et al*., (2009) studied the effect of different substrata on the growth survival of *Perna viridis* in Raft Culture at Ratnagiri (India). According to their result, the mussel is better on nylon rope compared with nylon strip in 7 months (Soon *et al*., 2016). The green mussel attained the shell length of 67.3± 0.7 and 65.5 ± 0.62 mm for nylon rope and nylon strip rens, respectively with the average survival of 54.09% in nylon rope and 35.26% for nylon strip rens in 7 months during raft culture. It was found that because of continuous water current, the substrata, which is lighter than rope substrata, does not withstand against prevailing water current resulting slippage of mussels from nylon rope substrata. The cages fitted on the rack at Sitaw seem to withstand against water current and the lower survival rate (35%) in Shwekyungyi may be due to the unstable substrata in the nets.

The accumulation of silt in the cages was observed at Sitaw, however, the growth and survival rate of green mussels in this site showed greater than that of mussels in Shwekyungyi. Segnini de Bravo *et al*., (1998) stated that *P. viridis* can colonize even muddy sediments, point to the high level of tolerance of the green mussels to high suspended particulate matter. Shin *et al*., (2002) also found that *P. viridis* collected from Tolo Harbour, Hong Kong to tolerate a high level of suspended particulate matter (up to 1200 mg l).

The epibiotic barnacles were observed on the growing mussel shells at both Sitaw and Shwekyungyi. Sounararajan *et al*., (1988) and Karayucel *et al*., (2002) described that fouling of mussels by barnacles was heavy over the culture materials. Bell (2013) reported that there is no negative impact of epibiotic barnacles on the growth and condition index of mussels. Barnacle epibionts create a new interface between the mussel and its environment and this interaction can affect other members of the community. The barnacles settle on the mussel shells only as a secondary choice. Anil *et al*., (2017) also observed the fouling organisms such as sponge, tiny crabs, bigger crabs and other epifauna growing on the cage.

The fouling of epibionts at Sitaw was fewer than at that of Shwekyungyi. This may be because of a high fluctuation of salinity at Sitaw. Deaton, (1981) and Yuan *et al*., (2010) reported that *P. viridis* can survive in the horohalinicum salinity zone which serves as a barrier between

fresh and marine species, where estuarine salinity ranges from 3–8 ‰, and where many species cannot survive. In addition, *P. viridis* can successfully adapt over the long term to salinities between 19 ‰ and 44 ‰. A far greater fouling of the mussels growing on ropes (at Shwekyingyi) was probably because they were submerged continuously. In contrast to this, the mussels in the intertidal zone (Sitaw) were exposed to atmospheric conditions at the ebb tide. Thus periodic desiccation seems to prevent growth of fouling organisms.

Generally near neutral to slightly alkaline pH is considered ideal for the aquatic organisms. The acceptable pH range for most finfish and shellfish species is 6.8-8.5 (Sasikumar, 2007). During the study period pH value observed at Ye eatuary ranged from 6.4 to 7.6 and from 7.52 to 9.38 at Shwekyungyi. pH values observed at Shwekyungyi was higher than the optimal value for the growth and survival of mussels between 6.0 and 8.2 (Sivalingam, 1977). The lower growth and survival rate of *Perna viridis* seemed due to high pH value and heavy biofouling organisms at Shwekyungyi.

Water quality of Sitaw, Ye estuary is found to be suitable especially for growth and survival of mussels. The absence of diffuse agricultural input, domestic and industrial discharges in the study areas seem to favour observe the healthy mussels from these areas. Sitaw is the estuary where Ye River meets the sea. Moreover, water draining from the uplands carries sediments, nutrients and pollutants. As the water flows through fresh and salt marshes, much of the sediments and pollutants are filtered out. This filtration process cleans water, which benefits both people and marine life. Sitaw area, therefore, should be selected for the culture of *P. viridis* and the optimum sizes of about 10-25 mm should be seeded and the culture period of around 5 months was optimum in a favorable season.

Summary

The present study is the very first step to develop mussel production through the hatchery technique and grow out culture of *P. viridis* in Myanmar. Results of the present experimental culture indicated that green mussel can successfully be cultured commonly in Sitaw through rack by using cage culture method. The result of this study is encouraging as this can be successfully induced to spawn in a low cost yet effective way. Significant investments, however, are needed to develop hatchery production at a scale that would be economically viable. Development of efficient settlement and nursery systems remains the main challenge. The farming of mussels still not practiced artificially in Myanmar; however, this study revealed the artificial culture of green mussels as alternate livelihood of poor fishermen community settled around the coastal belt of the province. Through this study, the culture technology of green mussels can be transferred at gross root level and the coastal community can be trained on mussed culture. Though more works need to be done to establish a complete larval rearing protocol, this study shed positive lights on introducing new species to the local mariculture industry to Myanmar, empowering the local with simple yet effective bivalve culture technique and enable species restocking in the coastal ecosystem when necessary in future. It is hoped that this brochure will create awareness on mussel farming techniques, production, handling and further value addition for marketing. The information provided here will certainly make small scale farming of mussels more popular and generate greater employment opportunities and income in the future.

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ISOLATION OF PROTEIN FROM DIFFERENT INDIGENOUS BEANS AND ITS UTILIZATION IN FOOD INDUSTRIES

ISOLATION OF PROTEIN FROM DIFFERENT INDIGENOUS BEANS AND ITS UTILIZATION IN FOOD INDUSTRIES

Zar Zar Oo[1]

Abstract

This research work focused on isolation of the most refined form of protein from beans viz. Mung bean (Vigna radiata L), lentil (Lens culinaris L.) and chick-pea (Cicer arietium L.) collected from Monywa Township, Sagaing Region. The nutritional values of beans such as protein content, moisture content, ash content, fiber content, carbohydrate content and fat content were firstly determined. The fat of raw bean flours was removed by bulk soaking in ethanol and followed by soxhlet extraction using ethanol as solvent before isolating the protein. The highest fat removal is 46.43 ± 0.03 % found in Mung bean flour while lentil flour showed the lowest fat removal is 29.03 ± 0.03 % under the condition of 1:5 (bean to solvent ratio) at the extraction temperature of 60 °C. The fiber and starch were removed from defatted bean flours by isoelectric precipitation method later protein was isolated by alkaline solubilization at pH 9.5 followed by acid precipitation at pH 4.5 resulting in the highest protein content,94.47 ± 0.02 % with the best functional properties such as protein solubility, water and oil absorption capacity, emulsion capacity and stability, foaming capacity and stability. Furthermore, its elemental compositions, surface morphology and biodegradability were investigated to determine the potential for keeping quality and safety of food products by applying the edible film. The film prepared with protein isolate (5 g per 100 ml, of water) and 4 ml, glycerol having 120 cm^2 dimension provided the agreeable properties. In chicken sausages preparation, effect of amount of protein isolates, on the functional characteristics such as pH cooking loss, cooking yield, change in length and diameter, moisture and microbial analysis were determined. Sensory characteristics of sausages were also recorded. Chicken sausage prepared with 7% protein isolate as meat extender gave the favorable functional characteristics. Hence, the research findings could contribute to the improve food quality of products industry. The values of locally available beans are increased due to product processed in this research work.

Keywords: bean flour, defatted bean flour, isoelectric precipitation, bean protein isolate, edible film, sausages

Introduction

In the developing countries, protein malnutrition is one of the major important issues because animal proteins are high in cost and scarce than plant sources. So, plant protein is commonly consumed by vegetarian as a replacement for meat (Butt & Batool, 2010). Legumes are the second largest source of human food and play significant role in alleviating protein-energy nutrition. Human beings should depend on the legume proteins to meet the protein requirement in their diet (Sibt et al, 2015).

Mung bean (Vigna radiata L.) is important pulse crop belonging to the family Fabaceae. It is also called green gram, a tropical rain legume, widely cultivated in Asia. It is a rich source of protein and amino acids especially lysine and thus can supplement cereal based human diet (Habibullah & M, 2007). Lentil (Lens *culinaris* L.) belongs to the family leguminosae and there are many studies on the composition of lentil protein and its potential value in human diet. On the average, the percentage of protein in lentil seed is 20-25% (Bamdad, & Kadivar, 2006). Chick-pea (*Cicer arietinum* L.), is a member of the family Fabaceae (or Leguminosae), and is widely grown in tropical, subtropical, and temperate regions. Chick-pea is considered a good source of proteins and carbohydrates. (Aurelia, et al, 2009). Isoelectric precipitation is one of the commonly applied methods to produce isolated protein and this method depends on the application of different solubility. (Akaerue & Onwuka 2010).

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Bean protein isolates were used as a basic material in edible film due to its excellent source of protein (20-27 ^{0}/0), and its essential amino acid composition which is comparable favorably to soybean, kidney bean. Mung bean, lentil and chick-pea are inexpensive and are readily available in the market. The films can function as carriers for antimicrobial and antioxidant agents (Bourtoom, 2008). Sausages are products in which fresh comminuted meats are modified by various processing methods to yield desirable organoleptic and keeping properties. The growing demand by consumers for healthier products is stimulating the development of meat products with a reduced fat content. Proteins are used as meat extender because of their ability to bind water and form gels (Marya, et al, 2014).

2. Objectives of the Study

The overall objective of this study was to isolate the most refined form of protein from indigenous beans and their utilization in some food industries.

The specific objectives of this study were:

to determine the nutritional values of locally available bean flours

- to remove the fat, fiber and starch from flour for enhancement of protein isolation
- to isolate the protein from defatted flour
- to study the physico-chemical properties of protein isolates
- to study the alternative source of protein from beans into tablet, edible film and sausages

Materials and Methods

3.1 Raw Materials

Mung bean (Pedesein), lentil (Peyarzar) and chick-pea (Kalape) were collected from Monywa Township, Sagaing Region. Ethanol (95 %) (Analar Grade, BDH) was purchased from Able Chemical Store, 76th Street, between 27th & 28th Street, Chan Aye Thar Zan Township, Mandalay Region.

3.2 Preparation of Bean Flour

About 300 g of selected peas (mung bean, lentil and chick-pea seeds) collected from Monywa Township, Sagaing Region were individually washed with water for three times to remove foreign materials and then soaked in 1000 ml, of distilled water for 12 hr and dehulled. After that, the seeds were crushed to smaller fragments in a blender and then dried in an oven at 60°C for 12 hr. And then, they were powdered and sieved with 80 mesh screen and then stored in air tight containers.

3.3 Defatting of Bean Flour

3.3.1 Soaking in the Solvent

About 100 g of mung bean, lentil and chick-pea flours (80 mesh) were individually soaked in 600 ml-a of 95 % ethanol for 4hr. To determine the most suitable soaking time, the procedure was again repeated for different soaking time (8 hr, 12 hr, 16 hr, 20 hr and 24 hr) respectively. After soaking for respective period, the solvent was decanted and defatted flour was dried in an

oven at 60 °C for 12 hr. After that, they were ground in the grinder and sieved with 200 mesh screen. Then, defatted flour powders were packed in air-tight plastic bags.

3.3.2 Soxhlet Extraction Method

100 g of mung bean, lentil and chick-pea flours (80 mesh) were individually placed inside a thimble and loaded into the main chamber of the soxhlet extractor. 600 mL of 95 % ethanol was placed in a round bottom flask and extraction was done at 50^0C. To decide the highest fat removal temperature, the procedure was further conducted at 60^0C, 65^0C and 70^0C respectively. Moreover, the extraction was again conducted for all the respective bean flours by varying the flour to solvent ratio, 1:3, 1:4, 1:5, 1:6 and at the chosen extraction temperature, 60^0C. The defatted flours were dried in an oven at 60 ^{o} C for 12 hr. After that, they were ground in the grinder and sieved with 200 mesh screen. Then, defatted flour powders were packed in air-tight plastic bags.

3.4 Combination of Bulk Soaking and Soxhlet Extraction

100 g of mung bean, lentil and chick-pea flours were separately soaked in 600 mL of 95 % ethanol for 16 hr and followed by soxhlet extraction to concentrate the bean proteins. For mung bean and lentil, material to solvent ratio, 1:5 was entirely applied at extraction temperature 60 °C, for 20 hr, but the most favorable results were obtained with material to solvent ratio, 1:5 at extraction temperature 60 °C for chickpea by soxhlet extraction. In order to remove all the retained solvent, defatted flours sere dried in an oven at 60 °C for 12 hr. After that, they were ground in the grinder, sieved with 200 mesh screen and defatted flour powders were packed respectively in the air-tight plastic bags.

3.4 Preparation of Bean Protein Isolate

Protein isolates from defatted mung bean, lentil and chick-pea were individually prepared by using isoelectric precipitation method. About 100 g each of defatted mung bean, lentil and chick-pea flours were separately dispersed in distilled water in 1:10 (w/v) (defatted flour: water) ratio and flour suspensions were adjusted to pH 9.5 for mung bean, pH 11.3 for lentil and pH 10.5 for chick-pea by using 2.6 mL of 2N NaOH solution at room temperature. Fiber and starch fractions were separated by centrifugation (DSC-200A-2, Digit system Laboratory Instruments Inc., TAIWAN) at 3500 rpm for 40 min. and the supernatant was collected. The pH values were adjusted to 4.5 for mung bean and chick-pea but the most favorable results occurred at pH 4.7 for lentil with 2 N of HCI solution to precipitate the proteins. Then proteins were isolated by centrifugation at 3500 rpm for 40 min. The precipitates were washed with distilled water for three times, to achieve a complete removal of any existing contaminants. The precipitates were allowed to dry at room temperature for 10 hr and then milled to pass 200 mesh screen and protein isolate powders were packed respectively in the air-tight plastic bags.

3.5 Analysis of Bean Protein Isolate

Physico-chemical properties of mung bean, lentil and chick-pea flours and defatted flours such protein content, moisture, ash, fiber, carbohydrate, fat content (AOAC-Method, 2000) were determined at the Myanmar Pharmaceutical Factory, Sagaing Region. Physico-chemical properties of protein isolates from prepared defatted mung bean, lentil and chick-pea flours such as protein, moisture, ash fiber, carbohydrate, fat contents and also protein solubility, water absorption capacity, oil absorption capacity, emulsifying activity and stability, foaming capacity and stability of protein isolates were determined. The various functional groups was examined by FT-IR, Fourier Transform Infrared Spectroscopy (Perkin Elmer, 8400, Shimadzu) and SEM; (Scanning

Electron Microscope) was used to measure the surface morphology of the mung bean, lentil and chick-pea protein isolates respectively.

3.6 Application of Bean Protein Isolate

In utilizing the protein isolate in the selected food industries (tablet formulation, edible film and sausages preparation), mung bean protein isolate was decided to use because of its relatively high protein content and the lowest fat and fiber content. Furthermore, mung bean protein isolate showed higher water and oil absorption capacities and emulsion stability that influencing the functional characteristics of foods than lentil and chick-pea protein isolates.

3.6.1 Preparation of Bean Protein Tablet

Firstly the protein paste, 5 g of protein powder and 10 mL of distilled water were prepared and formed into tablet (size of tablet, mm) by using manual tablet press machine and dried at 55°C for 4 hr in an hot air oven. They were then packed with air-tight plastic bags and stored at room temperature, 30°C.

3.6.2 Procedure of Edible Film

Films were prepared by dispersing 5 g of mung bean protein isolate in 100 ml, of distilled water and 4 ml, of glycerol. The procedure was further carried out by varying the amount of protein isolate (1, 3, 5, 7 & 9 g) respectively. Protein isolate solution was stirred using magnetic stirrer (J.P.SELECTA, s.a, SPAIN) at 1000 rpm for 30 min. The pH was adjusted with 2N of NaOH because the alkaline pH might enhance tensile strength and elongation at break. And then the solution was stirred for additional 15 min. The solution was heated in a water bath at 80 ^{o}c for 20 min. The film solution was cooled to 30 °C for 10 min. The film was casted on Teflon-coated glass plate to form a thin film and dried in an oven (J.P.SELECTA, s.a, SPAIN) at 60 °C for 12 hr. The dried bean protein isolate film was then peeled off. The resultant film was dried at room temperature.

3.6.3 Processing of Chicken Sausages

The fresh chicken was washed with chilled water, beheaded, and again washed with chilled water to remove fat and undesirable materials such as blood, and odorless substances, thereby improving the gel-forming ability of the final product. Minced chicken 100 g was washed with distilled water and chilled in ice bath at 0 °C for 60 min. Before chilling, it was mixed with cryoprotectants such as 2 g sugar, 0.2 g of sodium pyrophosphate and 0.2 g of sodium nitrite to minimize the damage during freezing. Some food additives such as 2 g of salt, 0.5 g of ginger, and 7 g of bean protein isolate as extender were added and the whole mass was blended in a blender to get a uniform paste. The final product was rolled and packed in bean protein based edible film. It was pasteurized in an oven at 60 °C for 20 min. The finished product was then frozen and stored at -5 °C in a deep freezer. The procedure was further conducted with different amounts of bean protein isolate (l, 3, 5, 7 and 9 g) individually.

Results and Discussion

4.1 Nutritional Values of Selected Bean Flour

Nutritional values of bean flour are shown in Table (4.1). Chick-pea had the highest crude fat content, 5.76 ± 0.02 % followed by lentil, 1.17 ± 0.04 % and mung bean, 1.08 ± 0.01%. Lentil had the highest crude protein content, 22.58 ± 0.07 %, it was very close to the mung bean, 22.49 0.03 % but chick-pea had only 19.94 ± 0.03 %. Lentil had the highest carbohydrate content, 63.53 ± 0.03 %, followed by chick-pea, 62.08 ± 0.02 % and mung bean 59.77±0.02 %. It was observed that the crude fibers of local flours were significantly different and their high fiber content may be due to bean's hulls. Thus, dehulling can reduce the fiber content. The proximate composition of bean flour can be varied depending on the weather and soil conditions, cultivation area, and species of flour, harvesting time and storage condition.

4.2 Defatting of Bean Flour (By Soaking in the Ethanol Solution)

4.2.1 Effect of Soaking Time on the Percentage of Fat Removal and Protein Content from Bean Flour

The effect of soaking time on the percentages of fat removal and protein content from bean flour are shown in Table (4.2).The percentage of fat removal from mung bean flour and chick-pea flour increased from 48.15 ± 0.02 % to 52.33 ± 0.03 % and 47.00 ± 0.02 % to 50.43 ± 0.02 % respectively after soaking for 16 hr to 24 hr in 95 % ethanol solution. There was only 3 to 4 % of protein content and fat removal of mung bean flour increased between 16 hr and 24 hr long soaking time. So, 16 hr was the most suitable soaking time for mung bean flour and lentil flour. The highest percentage of fat removal and protein contents, 21.01 ± 0.03% and 22.45 ± 0.03 % respectively for chick-pea were occurred for soaking 20 hr in ethanol solvent. By increasing soaking time from 20 hr, there was no significant increase in both percentages of fat removal and protein content.

4.2.2 Extraction of Fat from Bean Flour to Concentrate the Protein (By Soxhlet Extraction)

4.2.2.1 Effect of Extraction Temperature on the Percentage of Fat Removal and Protein Content from Bean Flour

The effect of extraction temperature on the percentages of fat removal and protein content of mung bean, lentil and chick-pea of defatted flour by soxhlet extraction are presented in Table (4.3). It can be seen that protein content steadily increased from 31.43 ± 0.04 % to 33.79 ± 0.02 % and also percentage of fat removal gradually progressed from 49 ± 0.06 % to 62.03 ± 0.02 % with increase in extraction temperature of mung bean flour from 50 °C to 60 °C. However, increasing the temperature from 60 °C to 70 °C did not obviously bring about the increase in fat removal and protein content. The similar situation was also encountered for lentil and chick-pea flour. Moreover, high temperature may cause protein denaturing. Thus, 60 °C was found to be the most suitable temperature for extraction of fat from mung bean flour, lentil flour and chick-pea flour.

4.2.2.2 Effect of Ratio of Bean Flour to Solvent on the Percentage of Fat Removal and Protein Content

Furthermore, to decide the most suitable ratio of bean flour to solvent on the fat removal and protein content of defatted flour by soxhlet extraction, the bean to solvent ratio were varied from 1 :3 to 1:7 at the extraction temperature of 60 for extraction time of 6 hr. The resultant data are shown in Table (4.4). It was found that percentage of fat removals and protein contents of lentil flour and chickpea flour were quite lower than that of mung bean flour. By using bean to solvent

ratio 1:6, defatted mung bean flour had the protein content, 33.47 ± 0.04 % with the fat removal, 60.19 ± 0.02 % but defatted chick-pea flour had protein content, 28.12 ± 0.02 % with fat removal, 37.29 ± 0.02 % These variations of fat removals and protein contents of selected bean flours might be due to the different in composition of flours. Therefore, the ratio of 1:6 is the most suitable bean to solvent ratio for bean flours.

4.2.3 Defatting of Bean Flour (By Combining the Bulk Soaking in the Ethanol Solvent and Soxhlet Extraction)

4.2.3.1 Effect of Ratio of Ethanol Soaked Bean Flour to Solvent on the Percentage of Fat Removal Protein Content

To enhance the fat removal percentage, the experiment was again carried out with formally soaked in ethanol solvent flour by solvent extraction. The effect of ratio of ethanol soaked bean flour to solvent on the percentage of fat removal and protein content from bean flours are shown in Table (4.5). It has been observed that combined effect of bulk soaking and soxhlet extraction had influence on the maximum removal of fat contents. By combining the two processes, the fat removal percentages were 46.43 ± 0.03 %, 29.03 ± 0.03 %and 45.05 ± 0.02 % for mung bean, lentil and chick-pea respectively with 1 (bean to solvent ratio) at extraction temperature of 60 °C. There was no significant changes in these two percentages by increasing the ratio of ethanol soaked bean flour to solvent to a certain limits. It was seen that the protein content occupied in defatted mung bean and lentil flours were very close to each other but due to protein denaturing significantly lower protein content was present in defatted chick-pea flour.

4.2.4 Characteristics of Defatted Flour

Characteristics of defatted flour for respective beans are shown in Table (4.6). The ash content of defatted mung bean flour 1.93 ± 0.03 % was lower than that found in defatted chick-pea flour with contents of 2.44 ± 0.01 %. It was found that defatting significantly decreased the crude fiber content from 0.74 ± 0.01 % for mung bean flour to 0.23 ± 0.04 % for defatted mung bean flour. The ash and fiber contents of defatted mung bean flour were reduced to 1.93 ± 0.03 % and 0.23 ± 0.04 % respectively since this might be leached out in the ethanol solution during soaking the bean flour.

4.2.5 Isolation of Protein from Defatted Flour

4.2.5.1 Effect of Volume of 2N NaOH Solution on the Fiber and Starch Removal from Defatted Flour by Isoelectric Precipitation Method

To isolate the protein, the effect of volume of 2N NaOH solution on the fiber and starch removal and protein content from individual defatted flours are described in Table (4.7). The data of the present study declared that protein contents were gradually enhanced with increase in pH value which was influenced by the added amount of NaOH solution. However, the protein content from defatted mung bean flour, 82.68 ± 0.02 % was obtained at pH 9.5 and those of lentil and chick-pea proteins, 81.24 ± 0.06 % and 69.13 ± 0.06 % were achieved at pH 11.3 and 10.5 by using 2.6 mL of NaOH solution respectively. Increasing the pH of the extraction solutions resulted in higher protein contents. These suggested that increasing pH might have contributed to better solubilization of proteins, thus facilitating its extraction. The variations in protein contents of different protein isolates could be due to the extent of soluble proteins present in defatted flours used for isolation.

4.2.5.2 Effect of Centrifugation Speed on the Isolation of Protein, Fiber and Starch Removal from Defatted Flour by Isoelectric Precipitation Method

The effect of centrifugation speed on the protein content and removal of fiber and starch from defatted flours are shown in Table (4.8). Most of the fiber and starch were removed by centrifugation after alkaline extraction. It was found that the fiber and starch removal percentages and protein contents of defatted lentil and chick-pea flours were lower than that of the defatted mung bean flour. The protein content of mung bean protein isolate slightly increased to 84.34 ± 0.04 % from 80.68 ± 0.01%, lentil protein isolate gradually progressed to 83.67 ± 0.05 % from 78.62 ± 0.04 % and chick-pea protein isolate content increased to 70.67 ± 0.02 % from 65.24 ± 0.04 % at 3500 rpm for 30 min due to high rate of compaction of solid phase resulting from higher centrifugal speed. However, there was no sharp change in fiber and starch removals between 3500 rpm and 4000 rpm for mung bean protein isolate. So, the most suitable centrifugation speed of bean protein isolate was found to be 3500 rpm.

4.2.5.3 Effect of Centrifugation Time on the Protein Content, Fiber and Starch Removal from Defatted Flour by Isoelectric Precipitation Method

Since centrifugation time was one ofthe influencing factor for the removal of fiber and starch, the effect of it on the protein content were studied. The resultant data are described in Table (4.9). Comparatively, lower fiber and starch removals were observed for chick-pea protein isolate, 43.48 ± 0.02 % and 54.61 ± 0.05 % respectively, the consequence was lower in its protein content, 72.12 ± 0.04 %. It was observed that the protein contents of three protein isolates gradually increased by changing the centrifugation time. Among them, maximum protein content was noted for mung bean protein isolate, 85.79 ± 0.04 % at the centrifugation time of 40 min based on different protein solubility from different bean flours. Thus, the most suitable centrifugation time of bean protein isolate was 40 min.

4.2.5.4 Effect of pH on the Protein Content and Percentage of Fiber and Starch Removal by Isoelectric Precipitation Method

Furthermore, the largest precipitation of protein can occur at the most suitable acidic pH and pH of the protein solution were gradually changed from 4.1 to 4.9. Effect of pH on the protein precipitation and fiber and starch removal percentages from the most solubilized protein concentrated solution are shown in Table (4.10). The highest removal of fiber and starch was achieved for mung bean protein isolate, 54.54 ± 0.05 % and 69.74 ± 0.07 % but the lowest for chick-pea protein isolate, 51.28 ± 0.4 % and 58.30 ± 0.4 ^{0}/0. Moreover, the highest precipitation of proteins recorded with mung bean protein isolate, 94.47 ± 0.02 % whereas the lowest precipitation occurred with chick-pea protein isolate, 83.10 ± 0.3 % at pH 4.5 respectively due to other components might be co-precipitated at pH 4.5 during protein recovery differently. So, pH 4.5 could provide the highest yield of protein isolate from defatted mung bean flour.

4.2.6 Characteristics of Bean Protein Isolate

Characteristics of different protein isolate were determined. The results are shown in Table (4.11). It was found that the protein isolate from mung bean had the lowest fiber, 0.05 ± 0.07 % whereas the protein isolate from chick-pea had the highest fiber, 0.19 ± 0.4 % among the three isolates. Mung bean protein isolate had the highest protein content, 94.47 ± 0.02 ^{0}/0, followed by lentil protein isolate, 84.12 ± 0.06 % and the chick-pea protein isolate, 83.10 ± 0.3% due to the extent of soluble proteins present in initial legume seed flour used for isolation. Furthermore, the ash content ofmung bean protein isolate was lower than that of lentil and chick-pea protein isolates

that might be the extent ofthe amount of sodium chloride formation through the neutralization process during preparation of protein isolates by isoelectric precipitation. By refinement, the carbohydrate contents, one of the significant characteristics of protein isolate substantially diminished, 3.74 ± 0.07 % for mung bean, 7.87 ± 0.02% for lentil and 7.71±0.4% for chick-pea.

4.2.7 Functional Properties of Bean Protein Isolate

Protein has both hydrophilic and hydrophobic properties thereby can interact with water and oil in food system. As shown in Table (4.12), mung bean protein isolate had water absorption capacity of 1.93 ± 0.06 ml, H_2O/g, lentil protein isolate 1.82 ± 0.07 ml, H_2O/g and chick-pea protein isolate 1.65 ± 0.12 ml. H_2O/g. It has been reported that the chick-pea protein isolate exhibits poor water binding capacity compared to that of the mung bean protein isolate and lentil protein isolate. Water binding properties of protein is determined by their degree of interaction with water. Protein isolate has a higher capacity of swelling, distortion and separation that allows additional exposure of binding sites for water and increases the water absorption. The oil absorption capacity of mung bean protein isolate was 2.11 ± 0.07 mL, oil/g but 1.95 ± 0.06 mL oil/g for lentil protein isolate and 1.72 ± 0.34 mL oil/g for chickpea protein isolate. Mung bean protein isolate showed higher oil absorption capacity than that of lentil and chick-pea.lt was found that mung bean protein isolate had not only good water and oil absorption capacities but also had the highest emulsion stability, 61.45 ± 0.02 %. Emulsion stability of lentil protein isolate and chickpea protein isolate were 41 ± 0.02 % and 40.12 ± 0.33 % respectively. Differences in the emulsion stability of protein isolates may be related to their protein composition, solubility and conformational stability. Hydrophobicity of proteins has influenced their emulsifying properties. The foaming capacity of mung bean protein isolate was similar to that of the chick-pea protein isolate but lentil protein isolate had the lowest.

4.2.7.1 Protein Solubility of Bean Protein Isolate

The protein solubility of isolated proteins at different pH ranges between 2 and 12 are presented in Figure (4.1). The minimum solubility was observed at pH 4 to 6 and maximum solubility occurred at pH 8 to 12. Therefore, lack of electrical charge for pH 4.5, negatively influenced the water binding and the solubility of protein. The isoelectric point of mung bean protein isolate and chick-pea protein isolate were at pH 4.5 whereas lentil at pH 4.7. When compared to the solubility behaviors between pH 4 and 6, both mung bean protein isolate and lentil protein isolate exhibited lower values than chick-pea protein isolate. On the other hand, the protein solubility started increase at pH 5 and reached its maximum value at pH 12, the protein solubility was 91 % for mung bean protein isolate, 86 % for lentil protein isolate and 84 % for chick-pea protein isolate while in the case of pH 2, the protein solubility was 68 % for mung bean protein isolate, 60% for lentil protein isolate and 53 % for chick-pea protein isolate respectively. For pH 9 to 12, the net electrical charges were high, and allow rejection forces between the protein chains and thus the protein solubility increased. The decrease of protein solubility in the chick-pea protein isolate compared to mung bean protein isolate and lentil protein was due to the occurrence of protein denaturing and insolubilization processes. Higher solubility ofmung bean protein isolate indicates good functionality, promising food application in beverage supplementary food.

4.2.7.2 Emulsion Capacity of Bean Protein Isolate

The emulsion capacity is an indicator used to evaluate the emulsion stabilizing properties of the protein isolates. Emulsion capacity of different protein isolates at different pH values are shown in Figure (4.2). The emulsion capacity of mung bean protein isolate was larger than that of

chick-pea and lentil protein. The maximum level of emulsion capacity was recorded at pH 8 to 12, emulsion capacity of 90.42 % at pH 10 and 92.33 % at pH 12 for mung bean protein isolate meanwhile emulsion capacity of 65.58 % at pH 10 and 73.44 % at pH 12 for lentil protein isolate and emulsion capacity of 79.02 % at pH 10 and 80.1 % at pH 12 for chick-pea protein isolate. Lower emulsifying properties of these protein isolates were found at pH 4 to 6. The lowest values recorded at pH 4 were 36.33 % for mung bean protein isolate, 39.66 % lentil protein isolate, and 55.64 % for chick-pea protein isolate owing the net electrical charges of proteins were zero.

4.2.7.3 Foaming Stability of Bean Protein Isolate

Stability of foam is ensured by the ability to foam film found around the air bubbles to remain intact without leakage, therefore, stable foams can be formed by agents with a high surface activity (Aurelia, et al, 2009). Although foaming stability percentage decreased gradually, the foam was developed and stood for 150 min at room temperature. The foam volume reached to 84.42 % for mung bean protein isolate, 50.4 % for lentil protein isolate and 82.5 % for chick-pea protein isolate as shown in Figure (4.3). Good stability of foam has been resulted for mung bean protein isolate and chick-pea protein isolate because of globular proteins having good surface properties.

4.2.8 Identification of Bean Protein Isolate

4.2.8.1 FT-IR Band Assignment of Bean Protein Isolate

Various functional groups of different protein isolate were determined by FT-IR in Table (4.13) and the respective spectra are shown in Figure (4.4). The main absorption bands of peptide linkages were related to C=O stretching at 1643.41 cm^{-1} for mung bean isolate, 1635.09 cm^{-1} for lentil protein isolate and 1625.08 cm^{-1} for chick-pea protein isolate represent amide primary, N-H bending and C-N stretching at 1526.71 cm^{-1} for mung bean protein isolate, 1528.64 cm^{-1} for lentil protein isolate and chick-pea protein isolate represent amide secondary. In addition, the bands observed 2971.44 cm^{-1} for mung bean protein isolate, 2970.48 cm^{-1} or lentil protein isolate, 2928.04 cm^{-1} for chick-pea protein isolate were due to the presence of CH and OH stretching. Thus, these were normal bean protein isolates consisting of amide, carboxylic acids and carbonyl groups.

4.2.8.2 Surface Morphologies of Bean Protein Isolate

Surface morphologies of protein isolate are illustrated in Figures (4.5 a, b and c). The SEM image of the mung bean protein isolate showed smooth and oval shape at pH 4.5 but lentil and chickpea protein isolates were denatured due to the less of soluble protein at isoelectric point. Hence, based on the above result, it was anticipated that mung bean protein isolate produced more textured product rather than the lentil and chick-pea protein isolates because of having noticeable higher protein content.

4.2.9 Organoleptic Properties of Bean Protein Isolate

Organoleptic properties of bean protein isolates such as color, flavor and texture are shown in Table (4.14).

4.3 Utilization of Bean Protein Isolate

4.3.1 Characterization of Bean Protein Tablet

Protein-Energy Malnutrition (PEM) is the most lethal form of malnutrition. Hospitalization may be needed in advanced cases of Protein Energy Malnutrition (PEM) with infections and other

complications. Management of PEM is carried out mainly by nutritional rehabilitation. Global database on Child Growth and Malnutrition, 87% of the total population of under-5-year-olds in developing countries such as Afghanistan, Ethiopia, Nepal and Bangladesh etc. There were nearly 925 million under nourished people in the world. The incidence of under nourished people in the world is 32% in 1970, 20% in 1980, 10% in 2010 and 17% in 2011. About 400-500 million children suffer from chronic protein energy malnutrition in the world (WHO, 2008). During the past six years, Myanmar has made a significant stride in improving the nutrition of children age five and under but the problem of malnutrition remains a serious concern in the country. Not only poor children but also rich families can suffer from malnutrition, especially those from remote or conflict areas,

For producing tablet, variation in weight was controlled by compression force and requires a uniform granulation to function correctly. Bean protein isolate tablet was 5.8 kg/cm^2 of hardness, 0.3 % of friability and 40 min of disintegration time as average. So, it exhibited properties suitable for use as pharmaceutical excipients in oral tablet dosage forms. Protein tablet is the most popular one existing in the field of pharmacy because of its major advantages like self-administration, compactness and ease in the manufacturing.

4.3.2 Mechanical Properties of Edible Film

4.3.2.1 Effect of Amount of Different Bean Protein Isolate on the Characteristics of Edible Film

Film thickness, tensile strength and elongation at break of edible film using various protein isolates are shown in Table (4.15). The thickness of edible film is an important characteristics in determining the feasibility of packaging materials for food products. The thickness of the film affects other characteristics of the films, like tensile strength, elongation at break. Thickness of edible film using mung bean protein isolate ranged between 0.11 ± 0.02 mm and 0.24 ± 0.01 mm. whereas chickpea protein isolate films ranged between 0.19 ± 0.3 mm and 0.30 ± 0.4 mm. In this study, tensile strength of mung bean protein based edible film was higher than that of the lentil and chick-pea protein based edible films. This might be due to more affinity for higher number of hydrogen bonds formed on the edible film. Elongation at break is an indication of a film's flexibility and stretch ability (extensibility) of edible film. Comparatively, lower tensile strength and elongation at break were observed for chickpea protein based edible film than that of mung bean protein based edible film showing that mung bean protein based edible film was more flexible when subjected to tension. Edible film using chick-pea protein isolate was less stiff, weaker and less extensibility than mung bean protein isolate film because of lower percentage of protein content. Mung bean protein isolate would be feasible for edible film because of higher percentage of protein content as compared to the remaining chick-pea and lentil protein isolates.

4.3.2.2 Effect of Amount of Glycerol on the Mechanical Characteristics of Edible Film

Table (4.16) shows the effect of amount of glycerol on the characteristics of edible film. It was clearly observed that addition of I ml. glycerol had not increased the tensile strength of the resulting edible film but significant increase in tensile strength had resulted by the addition of 4 mL, glycerol. Gradual change in film thickness was observed by gradually increasing the amount of glycerol in the edible film. Film thickness was 0.19 ± 0.03 mm by using 4 mL of glycerol. Increase in thickness was due to increase amount of glycerol and might be glycerol molecules occupy voids in the matrix and interact with edible film forming polymer. It was observed that the addition of 4 mL of glycerol gave the maximum tensile strength of the edible film, 2.78 ± 0.02 MPa. But further addition of glycerol in edible film crimped and could not form as coating edible film for respective foods. It was found that mung bean protein isolate film with 4 mL of glycerol

had higher elongation at break, 70 ± 0.03 %. This might be due to reduction of intermolecular interactions between the polymer chains that impacted elongation and flexibility of the film. Furthermore, glycerol is hygroscopic material and can behave as water holding agent. Hence, moisture content of films was clearly affected by the glycerol amount present.

4.3.2.3 Effect of Dimension of Film on the Film Thickness, Tensile Strength and Elongation at Break

Table (4.17) describes the effect of dimension of edible film on the thickness, tensile strength and elongation at break of edible film. It was seen from Table (4.17) that 120 cm^2 dimension of protein based edible film with 0.06 ± 0.01 mm thickness produced clear transparent film, whereas 38 cm^2 dimension of bean protein based edible film with 0.18 ± 0.02 mm thickness produced a film with an opaque surface which was due to high molecular weight presence of hydroxyl groups in the film. The highest tensile strength of bean protein based edible film was 3.55 ± 0.02 MPa. Moreover, tensile strength of bean protein based film was comparable to that of conventional polyolefin films (3-10 MPa). 120 cm^2 dimension of bean protein film occupied higher percentage of elongation at break, 75 ± 0.02 % than remaining dimensions of bean protein isolate films. Bean protein isolate based film had acceptable quality for use as a packaging material such as individual wrappers with good mechanical applications.

4.3.2.4 Effect of Thickness on the Solubility of the Edible Film

Solubility is an important property for biodegradability and applications of edible film. Figure (4.7) describes the effect of thickness on the solubility of edible film. It indicated that the maximum solubility was observed for the film prepared by using between 0.06 mm and 0.04 mm thickness of bean protein isolate based edible film whereas 0.18 mm to 0.11 mm thickness of bean protein isolate based edible film gave the minimum solubility. If the edible packaging film is soluble, it is convenient to pack for ready to eat food products as it melts in boiled water or in the consumer's mouth.

4.3.2.5 Effect of Thickness on the Transparency of the Edible Film

Transparency is one of the common optical properties of light permeable materials. Spectrophotometer was used to measure the transparency of a material by light-transmittance or absorbance. Development of transparent packaging materials product visibility and requirement for packaging film industry. Figure (4.8) shows the effect of thickness on the transparency of edible film. Bean protein based edible film had a transparency of 4.51 ± 0.05, indicating good transparency of the film. The transparency of protein film was relatively close to synthetic polymer films, polyvinylidene chloride (PVDC) (wrapping film available from Zegyo market) with transparency of 4.58, thus the films were clear enough to be used as see-through packaging material.

4.3.2.6 Effect of Dimension on the Biodegradability of the Edible Film

The effect of dimension on the biodegradability of the edible film are described in Table (4.18). Soil burial test is a traditional way to test sample for degradation because of this similarity with the actual condition of waste disposal. The soil burial test was studied by evaluation of weight loss for the film overtime. After degradation of 4 days, phase defonnation occurred and the surface of the film became rough, which implied superficial erosion process resulting from microbial

attack in the film took place. The prepared bean protein based edible films clearly showed deformation after 4 days and complete degradation was found after 8 days.

4.3.2.7 Elemental Composition of Bean Protein Isolate Based Edible Film

The elemental compositions of bean protein isolate based edible film examined by EDXRF analyzer are shown in Table (4.19). It was found that the protein based edible film contained the highest amount of calcium and silicon as a result of less sticky and film flexibility. It was studied that the obvious elements in edible film were phosphorus, potassium and sulfur. Other obvious elements are iron, manganese and titanium.

4.3.2.8 Fourier Transform Infrared Spectroscopy of Bean Protein Isolate Based Edible Film

Figure (4.9) shows that the main FT-IR spectra of bean protein isolate based edible film. There was alkene groups at absorption of 989.52 cm^{-1}, C-O-C stretching of 1107.18 cm^{-1}, C-O stretching di-alkyl ether, C-H alkene bending was substituted at 1406.15 cm^{-1}; C=C non-conjugated amides at 1639.55 cm^{-1} ; C-H alkene stretching at 2945.40 cm^{-1} and OH and NH of protein film shifted from 3443.05 cm^{-1} , respectively. It was found that the crosslinking were present in blended compounds through hydrogen bonding and covalent bond formation, preferably with amino group of protein. This result indicated that interactions were present between the hydroxyl groups and the amino groups of bean protein isolate film.

4.3.2.9 Surface Morphology of Edible Film from Bean Protein Isolate

Surface morphology of bean protein isolate based edible film are shown in Figure (4.10). The surface morphology of the bean protein based edible film should be smooth, uniform, compact microstructure and free from defects for their functionalities. It was observed that 120 cm^2 in dimension of bean protein film showed homogeneous, uniform texture resulting in a more compact surface microstructure. The homogeneous matrix of film is a good indicator of its structure integrity, and consequently good mechanical properties.

4.3.2.10 Thermogravimetric and Differential Thermal Analysis

The thermal decomposition of protein film can be described in four steps and the results are shown in Figure (4.11). Initial stage of thermal degradation films observed at the temperature lower than 90 °C. The mass loss at this stage can be due to the removal of loosely bound water in the film. A small endothermic peak was observed at the region about 38.91°C. The second stage of thermal degradation range about 90-160 °C with a board endothermic peak appeared at 94.53 °C. The weight loss in this temperature range corresponding to loss of surface water and lower molecular compound (boiling point of glycerol). The third stage of thermal degradation of film occurred at the range of 1603 10 °C and an exothermic peak appeared at 165.51 °C and 298.17 °C. The weight loss in this temperature range corresponds to complete evaporation of glycerol (boiling point, 290 °C). The fourth stage occurred at the range of 300- 600 °C with the greatest weight loss corresponding to the complete degradation of the polymer. A very large and sharp endothermic peak was observed in each thermograph about 560.17 °C.

4.3.2.11 Application of Edible Film from Bean Protein Isolate

Generally, powdered soup, dried vegetables and other ingredients of precooked noodles and cup noodles, or instant coffee are packaged to maintain their qualities with either aluminum

laminated plastic or various plastic films. These packages must be torn to remove the contents prior to cooking or pouring hot water over it. This is not only troublesome, but also caused the packages to end up in the land-fill, where they can last forever and never degradable. One solution to these problems is to package such products with an edible film. The package can be dissolve by cooking or simply pouring hot water over it, thus making it unnecessary to tear the package and the material can be eaten together with the contents. This film can also be used as interleaf between foods to avoid it from sticking to each other, especially for frozen food such as burger.

Prepared edible film from bean protein isolate was used for wrapping fruits and vegetables (Figures 4.15 to 4.17). It was found that foods packed with edible film would last for 30 days without spoilage. This effect may be due to the antimicrobial and antioxidant property of the film. The delayed growth of microbes in vacuum packaging can be attributed to inhibition by low levels of oxygen and also extend shelf- life of oxygen sensitive products. In sensory evaluation, it was observed that sausage boiled after wrapping with edible film was more tender and delicious than pre-wrapping the sausages with edible film.

4.3.3 Functional Characteristics of Chicken Sausages

4.3.3.1 Effect of Amount of Bean Protein Isolate on the pH of Sausages

The addition of bean protein isolate influenced the pH of sausages. The sausages prepared with 7% bean protein isolate had the highest pH, but prepared with bean protein isolate 1% to 5% had the lowest pH value. pH of the sausage incorporated with 1 % to 9% bean protein isolate has been found to be 5.9 to 6.8 respectively. Slight decreases in pH prepared with 1 to 5 % bean protein based sausages might be attributed to the breakdown of glycogen with the formation of lactic acid. The results are shown in Table (4.20).

4.3.3.2 Effect of Amount of Mung Bean Protein Isolate on the Cooking Loss, Cooking Yield, Change in Diameter and Length

Cooking loss, cooking yield, change in diameter, and change in length (%) of different prepared chicken sausage samples containing 1%, 3%, 5%, 7% and 9% of bean protein isolate respectively were evaluated. Although cooking yield was significantly increased, cooking loss, change in diameter and length were notably decreased in different prepared chicken sausages containing different concentrations of bean protein isolate. Values of cooking loss and yield were 18.4 %, 17. %, 15.8 %, 12.5 %, 12.2 %, and 79.2 %, 80.4 %, 82.7 %, 84.3 % and 85.4 % for prepared chicken sausage samples contained 1%, 3%, 5% , 7% and 9 % of bean protein isolate, respectively. Similar trend was observed for the other cooking characteristics such as change in diameter and length of different prepared chicken sausages. The positive effect of addition of 7% bean protein isolate based sausage was observed in improving the cooking characteristics, especially, increase in the amount of bean protein isolate. These results could be correlated to the functional properties of bean protein isolate as a water binding material was the most important factor in improving cooking characteristics of meat products. Moreover, bean protein isolates are also excellent emulsifiers of fat as they have a high number of lipophilic (fat-loving or hydrophobic) groups within their molecules and can hold fat and water together in a meat product to create a stable network. High values of water and oil absorption capacity are convenient in the bean protein isolates that are used as ingredients in the cold meat industry like sausages because it improves mouth feel and flavor retention. The results are shown in Table (4.20).

4.3.3.3 Effect of Amount of Bean Protein Isolate on the Moisture Content of Sausages

The effect of amount of bean protein isolate on the moisture content of sausages are shown in Table (4.20). The level of added 7% bean protein based sausage was also a significant factor, with higher amount of added protein resulting in less moisture. The moisture content of 1%, 3% and 5% of bean protein isolate based chicken sausages were 6.5 %, 6.3 % and 5.8 % but 5.5 % for 7 % of bean protein isolate based sausages. The loss in moisture content during cold storage of sausage could be referred to moisture vapor migration from the surfaces of sausage samples as a result of difference in water vapor pressure with the surrounding cold air. From the results, it could be noticed that the addition of 7% bean protein isolate based sausage led to lower reduction in moisture content and improving the water holding capacity because of a lower loss of rate in moisture content of chicken sausage. Pea protein isolates are soluble proteins with good gelation, emulsification and water binding properties, thus these are challenges for applications in processed meat products.

4.3.3.4 Effect of Amount of Bean Protein Isolate on the Total Plate Count of Sausages

The resultant total plate counts were found lower microbiological standards of the EU Council (TPC/ 10^3 cfu/g) for food. According to these standards acceptable levels of total plate count were from 3 x 10^2 to 1 x 10^2 cfu/g by using different amount of protein isolate respectively. The results are shown in Table (4.20).

4.3.3.5 Effect of Amount of Bean Protein Isolate on the Sensory Characteristics of Sausages

The effect of amount of bean protein isolate on the sensory characteristics of sausages are shown in Table (4.21). Sensory characteristics like color, tenderness, juiciness, flavor and overall acceptability of prepared chicken sausage samples containing different concentration of bean protein isolate were evaluated. All levels of bean protein isolate in the chicken sausage resulted in increased consumer acceptability although chicken sausage with 7% mung bean protein isolate had the greatest acceptability. Lower cooking loss at higher protein levels resulted in juicier product, as protein traps fat and water in the matrix. It could be noticed that, 7% bean protein isolate incorporated sausage had a significant effect on improving the sensory characteristics of prepared chicken sausages and increased their acceptability during storage at 4°C. In general, higher amount of bean protein isolate increased the acceptability of prepared chicken sausages to a certain limit. Bean protein isolates are applied worldwide in order to add firmness and texture of the product. Binding of meat products like sausages are greatly enhanced owing to the addition of bean protein isolate and juiciness is also enhanced as a result of reduced weight loss during frying.

Table 4.1 Nutritional Values of Bean Flour

Sr. No.	Nutritional Values % w/w	Mung Bean Flour	Lentil Flour	Chick-pea Flour
1	Protein content	22.49 ± 0.03	22.58 ± 0.07	19.94 ± 0.03
2	Moisture content	12.72 ± 0.04	9.62 ± 0.05	8.21 ± 0.01
3	Ash content	3.20 ± 0.02	2.42 ± 0.06	3.01 ± 0.02
4	Fiber content	0.74 ± 0.01	0.68 ± 0.17	1.00 ± 0.03
5	Carboh drate content	59.77 ± 0.02	63.53 ± 0.03	62.08 ± 0.02
6	Fat content	1.08 ± 0.01	1.17 ± 0.04	5.76 ± 0.02

Table 4.2 Effect of Soaking Time on the Percentage of Fat Removal and Protein Content from Bean Flour (Soaking in Ethanol Solution)

Soaking Time in Ethanol (hr)	Mun Bean Flour		Lentil Flour		Chick- pea Flour	
	Fat Removal (% w/w)	Protein Content % w/w	Fat Removal (% w/w)	Protein Content % w/w	Fat Removal (% w/w)	Protein Content % w/w
4	21.30 ± 0.03	22.41± 0.02	10.26 ± 0.03	24.19 ± 0.04	12.5 ± 0.03	19.98 ± 0.01
8	31.48 ± 0.02	22.45 ± 0.01	16.24 ± 0.04	25.36 ± 0.01	13.36 ± 0.04	20.89 ± 0.03
12	42.59 ± 0.06	22.5 ± 0.03	25.64 ± 0.01	26.55 ± 0.05	17.01 ± 0.03	21.17 ± 0.02
*16	48.15 ± 0.02	23.15 ± 0.04	47.00 ± 0.02	27.69 ± 0.03	18.58 ± 0.02	21.99 ± 0.01
20	49.12 ± 0.04	23.22 ± 0.06	48.72 ± 0.03	27.77 ± 0.02	21.01 ± 0.03	22.45 ± 0.03
24	52.33 + 0.03	23.25 ± 0.01	50.43 ± 0.02	27.89 ± 0.01	21.53 ± 0.02	22.48 ± 0.02

*most suitable soaking time

Table 4.3 Effect of Extraction Temperature on the Percentage of Fat Removal and Protein from Bean Flour (Soxhlet Extraction)

Extraction Temperature	Mun Bean Flour		Lentil Flour		Chlck- pea Flour	
	Fat Removal (% w/w)	Protein Content (% w/w)	Fat Removal (%w/w)	Protein Content (% w/w	Fat Removal (% w/w)	Protein Content (%w/w)
50	49 ± 0.06	31.43 ± 0.04	12.82 ± 0.03	27.77 ± 0.01	34.38 ± 0.01	22.79 ± 0.01
55	53.7 ± 0.03	33.02 ± 0.02	33.33 ± 0.04	28.13 ± 0.03	35.76 ± 0.03	24.99 ± 0.04
* 60	60.19 ± 0.04	33.47 ± 0.05	49.01 ± 0.02	29.24 ± 0.02	37.29 ± 0.02	28.12 ± 0.01
65	61.11 ± 0.02	33.67 + 0.01	49.86 ± 0.05	29.45 ± 0.01	37.32 ± 0.02	28.14 ± 0.02
70	62.03 ± 0.02	33.79 ± 0.02	49.72 ± 0.03	29.57 ± 0.04	37.34 ± 0.03	28.69 ± 0.01

*most suitable extraction temperature

Table 4.4 Effect of Ratio of Bean Flour to Solvent on the Percentage of Fat Removal and Protein Content (Soxhlet Extraction)

Ratio of Bean Flour to Solvent	Mung Bean Flour		Lentil Flour		Chick-pea Flour	
	Fat Removal (% w/w)	Protein Content (%w/w)	Fat Removal (%w/w)	Protein Content (%w/w)	Fat Removal (%w/w)	Protein Content (%w/w)
1:3	27.78 + 0.03	32.45 ± 0.02	19.64 ± 0.02	27.23 ± 0.04	19.66 ± 0.06	23.79 ± 0.01
1:4	37.03 ± 0.01	32.86 ± 0.03	27.35 ± 0.02	28.42 ± 0.02	22.35 ± 0.02	23.96 ± 0.04
1:5	50.0 ± 0.04	33.15 ± 0.05	37.61 ± 0.02	29.22 ± 0.05	36.61± 0.03	25.12 ± 0.01
*1:6	60.19 + 0.02	33.47 ± 0.04	49.01 ± 0.02	29.24 ± 0.02	37.29 ± 0.02	28.12 ± 0.01
1:7	62.19 ± 0.01	33.50 ± 0.01	49.72 ± 0.02	29.25 ± 0.01	38.72 ± 0.01	29.59 ± 0.01

*most suitable ratio of bean flour to solvent

Table 4.5 Effect of Ratio of Ethanol Soaked Bean Flour to Solvent on the Percentage of Fat Removal and Protein Content (Combining the Bulk Soaking in the Ethanol Solvent and Soxhlet Extraction)

Ratio of Ethanol Soaked Bean Flour to Solvent	Defatted Mung Bean Flour		Defatted Lentil Flour		Defatted Chick-pea Flour	
	Fat Removal (%w/w)	Protein Content (%w/w)	Fat Removal (%w/w)	Protein Content (% w/w)	Fat Removal (%w/w)	Protein Content (% w/w)
1:3	21.43 ± 0.04	49.75 ± 0.02	17.74 ± 0.02	52.35 + 0.01	38.46 ± 0.02	40.12 ± 0.03
1:4	28.57 ± 0.01	50.88 + 0.04	20.97 ± 0.01	54.77 ± 0.01	40.66 0.01	42.67 ± 0.02
*1:5	46.43 ± 0.03	51.37 ± 0.02	29.03 ± 0.03	56.35 ± 0.02	45.05 ± 0.02	44.83 ± 0.05
1:6	47.32 ± 0.04	51.46 ± 0.02	32.26 ± 0.03	56.39 ± 0.01	45.59 ± 0.03	44.85 ± 0.01
1:7	48.21 ± 0.01	51.59 ± 0.01	33.87 ± 0.01	56.41 ± 0.03	45.79 ± 0.04	44.86 ± 0.01

*most suitable ratio of ethanol soaked bean flour to solvent

Table 4.6 Characteristics of Defatted Flour (Combining the Bulk Soaking in the Ethanol Solvent and Soxhlet Extraction)

Sr.No.	Characteristics (^{0}/0 w/w)	Defatted Flour		
		Mung Bean	Lentil	Chick-pea
1	Protein content	51.37 ± 0.02	56.35 ± 0.02	46.83 ± 0.05
2	Moisture content	8.54 ± 0.01	10.14 ±0.01	7.65 ± 0.02
3	Ash content	1.93 ± 0.03	8.81 ± 0.06	2.44 ± 0.01
4	Fiber content	0.23 ± 0.04	0.53 ± 0.06	0.69 ± 0.03
5	Carbohydrate content	37.63 ± 0.01	23.73 ± 0.14	40.74 ± 0.01
6	Fat content	0.3 ± 0.02	0.44 ± 0.06	2.5 ± 0.02

Table 4.7 Effect of Volume of 2 N NaOH Solution on the pH, Percentage of Fiber, Starch Removal and Protein Content from Defatted Flour by Isoelectric Precipitation Method

Volume of NaOH (ml.)	Mung Bean Protein Isolate/(MPI)				Lentil Protein Isolate/(LPI)				Chick-pea Protein Isolate/(CPI)			
	pH	Fiber Removal (% w/w)	Starch Removal (% w/w)	Protein Content (%w/w)	pH	Fiber Removal (% w/w)	Starch Removal (%w/w)	Protein Content (% w/w)	pH	Fiber Removal (w/w)	Starch Removal (% w/w)	Protein Content (% w/w)
2.0	8.3	17.39 ± 0.02	49.88 ± 0.02	79.21 ± 0.02	9.3	16.98 ± 0.01	34.26 ± 0.04	76.11± 0.03	8.4	15.94± 0.06	26.68 ± 0.03	60.55 ± 0.02
2.2	8.7	21.74 ± 0.01	53.44± 0.03	80.56 ± 0.01	10	20.76± 0.03	43.95 ± 0.02	78.43 ± 0.05	9.3	20.28 ± 0.03	35.62 ± 0.02	64.22 ± 0.03
2.4	9.2	26.09 ± 0.04	56.63 ± 0.02	81.77 ± 0.03	10.6	24.52± 0.01	52.29 ± 0.02	80.43 ± 0.02	9.9	26.09 ± 0.05	44.50 ± 0.04	67.88± 0.04
*2.6	9.5	34.78 ± 0.06	58.99 ± 0.03	82.68 ± 0.02	11.3	30.19 ± 0.03	55.58 ± 0.01	81.24± 0.06	10.5	30.43 ± 0.02	47.5 ± 0.01	69.13 ± 0.06
2.8	9.7	39.13 ± 0.02	59.37 ± 0.05	82.83 ± 0.02	12	31.13 ± 0.02	55.92 ± 0.01	81.33± 0.02	10.8	31.88± 0.01	49.17 ± 0.03	69.82 ± 0.02

*most suitable volume of NaOH

Table 4.8 Effect of Centrifugation Speed on the Percentage of Fiber, Starch Removal and Protein Content from Defatted Flour by Isoelectric Precipitation Method

Centrifugation Speed (rpm)	Mung Bean Protein Isolate/(MPI)			Lentil Protein Isolate/(LPI)			Chick-pea Protein Isolate/(CP1)		
	Fiber Removal (%w/w)	Starch Removal (%w/w)	Protein Content (^{0}/0 w/w)	Fiber Removal (%w/w)	Starch Removal (%w/w)	Protein Content (%w/w)	Fiber Removal (%w/w)	Starch Removal (%w/w)	Protein Content (%w/w)
2000	21.74± 0.04	53.76± 0.05	80.68±0.01	24.52 ± 0.04	44.67 ± 0.03	78.62 ± 0.04	23.19 ± 0.02	38.07 ± 0.05	65.24 ± 0.04
2500	26.09±0.03	55.30± 0.02	81.27±0.05	26.41± 0.02	53.27 ± 0.02	80.67 ± 0.03	27.54 ± 0.03	45.88 ± 0.01	68.45 ± 0.01
3000	34.78±0.06	58.99±0.03	82.68±0.02	30.19± 0.03	55.58 ± 0.01	81.24 ± 0.06	30.43 ± 0.02	47.5 ± 0.01	69.13 ± 0.06
*3500	43.48±0.01	63.36±0.02	84.34±0.04	47.17±0.02	65.44 ± 0.02	83.67 ± 0.05	36.13 ± 0.03	51.18±0.02	70.67 ± 0.02
4000	47.83±0.02	64.68±0.08	84.85 ± 0.01	49.06 ± 0.03	65.49 ± 0.01	83.69 ± 0.03	37.68 ± 0.04	51.94 ± 0.02	70.99 ± 0.02

*most suitable centrifugation speed

Table 4.9 Effect of Centrifugation Time on the Percentage of Fiber, Starch Removal and Protein Content from Defatted Flour by Isoelectric Precipitation Method

Centrifugation Time (min)	Mung Bean Isolate/(MPI)			Lentil Protein Isolate/(LP1)			Chick-pea Protein Isolate/(CPI)		
	Fiber Removal (% w/w)	tarch Remo (%w/w)	Protein Content (% w/w)	Fiber Removal (% w/w)	Starch Removal (% w/w)	Protein Content (% w/w)	Fiber Removal (% w/w)	tarch Removal (%w/w)	Protein Content % w/w
10	30.43 ± 0.01	56.02 ± 0.01	81.55 ± 0.07	28.30 ± 0.07	59.88 ± 0.04	82.25 ± 0.06	24.63 ± 0.04	46.34 ± 0.02	68.62 ± 0.03
20	39.14 ± 0.03	60.24 ± 0.01	83.16 ± 0.02	39.62 ± 0.03	63.25 ± 0.03	83.11 ± 0.02	30.43 ± 0.06	48.01 ± 0.06	69.34 ± 0.02
30	43.4 8± 0.01	63.36 ± 0.02	84.34 ± 0.04	47.17 ± 0.02	65.44 ± 0.02	83.67 ± 0.05	36.13 ± 0.03	51.18 ± 0.02	70.67 ± 0.02
*40	52.17 ± 0.06	67.15 ± 0.06	85.79 ± 0.04	64.15 ± 0.05	66.87 ± 0.07	84.10 ± 0.04	43.48 ± 0.02	54.61 ± 0.05	72.12 ± 0.04
50	56.52 ± 0.03	67.66 ± 0.05	85.69 ± 0.01	66.04 ± 0.06	66.88 ± 0.05	84.08 ± 0.07	44.93 ± 0.01	56.19 ± 0.01	72.10 ± 0.03

*most suitable centrifugation time

Table 4.10 Effect of pH on the Protein Precipitation, Fiber and Starch Removal from the Most Solubilized Protein Solution by Isoelectric Precipitation Method

pH	Mung Bean Protein Isolate/(MP1)			Lentil Protein Isolate/(LPI)			Chick-pea Protein Isolate/(CP1)		
	Fiber Removal (%w/w)	Starch Removal (% w/w)	Protein Content (^{0}% w/w)	Fiber Removal (%w/w)	Starch Removal (%w/w)	Protein Content (%w/w)	Fiber Removal (% w/w)	Starch Removal (% w/w)	Protein Content (%w/w)
4.1	36.37 ± 0.01	46.04 ± 0.02	91.52 ± 0.04	60.38 ± 0.02	33.38 ± 0.03	76.13 ± 0.04	41.03 ± 0.5	47.11 ± 0.3	80.99 ± 0.4
4.3	40.91 ± 0.02	65.78 ± 0.06	93.97 ± 0.01	64.15 ± 0.04	37.42 ± 0.05	77.11 ± 0.05	46.15 ± 0.6	51.16 ± 0.2	81.76 ± 0.3
*4.5	54.54 ± 0.05	69.74 ± 0.07	94.47 ± 0.02	67.92 ± 0.04	44.21 ± 0.02	78.74 ± 0.03	51.28 ± 0.4	58.30 ± 0.4	83.10 ± 0.3
4.7	45.46 ± 0.02	61.49 ± 0.04	93.44 ± 0.05	69.81 ± 0.04	66.84 ± 0.05	84.12 ± 0.06	48.72 ± 0.3	51.59 ± 0.5	81.85 ± 0.2
4.9	42.73 ± 0.09	55.83 ± 0.06	92.74 ± 0.03	66.04 ± 0.03	42.94 ± 0.02	78.43 ± 0.03	43.59 ± 0.2	44.08 ± 0.6	80.44 ± 0.3

*most suitable isoelectric point

Table 4.11 Characteristics of Bean Protein Isolate

Sr. No.	Characteristics (% w/w)	Protein Isolate		
		Mung Bean	**Lentil**	**Chick-pea**
1	Protein content	94.47 ± 0.02	84.12 ± 0.06	83.10 ± 0.3
2	Moisture content	1.16 ± 0.01	5.20 ± 0.04	5.00 ± 0.3
3	Ash content	0.3 ± 0.02	2.23 ± 0.09	2.00 ± 0.2
4	Fiber content	0.05 ± 0.05	0.16 ± 0.04	0.19 ± 0.4
5	Carbohydrate content	3.74 ± 0.07	7.87 ± 0.02	7.71 ± 0.4
6	Fat content	0.28 ± 0.05	0.42 ± 0.24	2.00 ± 0.3

Table 4.12 Functional Properties of Protein Isolate

Sr.No.	Properties	Protein Isolate		
		Mung Bean	**Lentil**	**Chick-pea**
1	Water absorption capacity (mLH20/)	1.93 ± 0.06	1.82 ± 0.07	1.65 ± 0.12
2	Oil absorption capacity ml, oil/	2.11 ± 0.07	1.95 ± 0.06	1.72 ± 0.34
3	Emulsion stability (^{0}/0)	61.45 ± 0.02	41 ± 0.02	40.12 ± 0.33
4	Foaming capacity (^{0}%)	50.12 ± 0.03	22.67 ± 0.03	43.6 ± 0.22

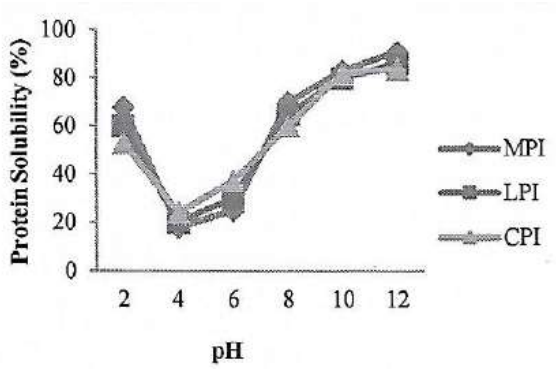

Figure 4.1 Effect of pH on the Protein Solubility of Different Protein Isolate

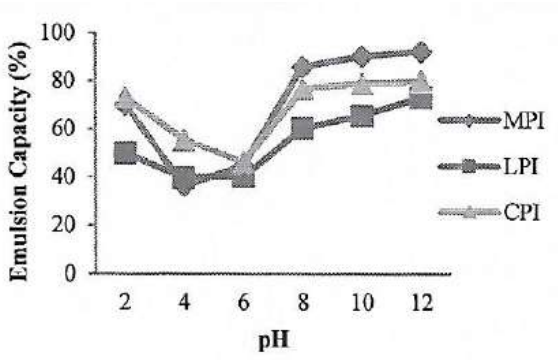

Figure 4.2 Effect of pH on the Emulsion Capacity of Different Protein Isolate

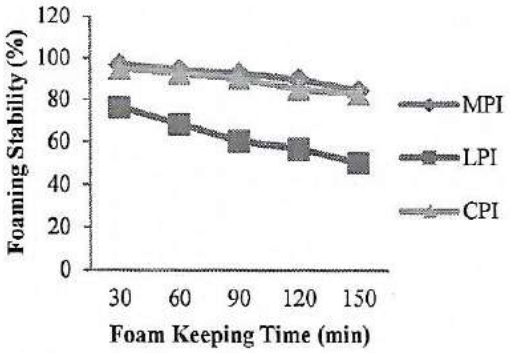

Figure 4.3 Effect of pH on the Foaming Stability of Different Protein Isolate

Table 4.13 FT-IR Band Assignment of Bean Protein Isolate by Isoelectric Precipitation Method

Sr.	Observed Frequency (cm-I)			*Literature (cm-I)	Band Assignment	Remarks
	Mung Bean Protein Isolate	Lentil Protein Isolate	Chick-pea Protein Isolate			
1	3390.97	3382.29	3343.71	3300-3500	H-bonded NH group	Amino group
2	2971.44	2970.48	2928.04	2500-3300	OH stretching and CH stretching	Carboxylic acid group
3	1643.41	1635.09	1625.08	1641-1660	C = O stretchin	Amide I group
4	1526.71	1528.64	1528.64	1524-1534	Out of phase combination of NH in plane bending and CN stretching vibration	Amide Il group
5	1245.09	1235.45	1248.48	1230-1250	In phase combination of NH bending and CN stretching vibration	Amide Ill group

*Kudre, 2013

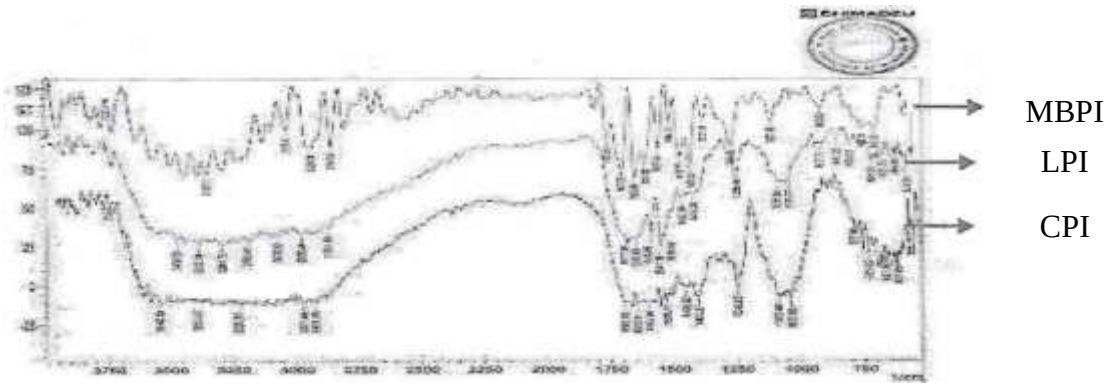

Figure 4.4 FT-m Spectrum of Bean Protein Isolate

(a) (b) (c)

Figure 4.5 Surface Morphologies of Bean Protein Isolate by Isoelectric Precipitation Method
(a) Mung Bean Protein Isolate
(b) Lentil Protein Isolate
(c) Chick-pea Protein Isolate

Table 4.14 Organoleptic Properties of Bean Protein Isolate

Mesh size = 200 mesh

Sr. No.	Protein Isolate	Organoleptic Properties			
		Color	Odor	Flavor	Texture
1	Mung Bean	white	pleasant smell	good	very smooth
2	Lentil	pale-yellow	pleasant smell	Good	smooth
3	Chick-pea	yellow	pungent smell	beany flavor	rough

(a) (b) (c)

Figure 4.6 (a) Mung Bean Protein Isolate (b) Lentil Protein Isolate(c) Chickpea Protein Isolate

Table 4.15 Effect of Amount of Protein Isolate on Film Thickness, Tensile Strength and Elongation at Break

Amount of Protein Isolate	Mung Bean Protein Based Edible Film			Lentil Protein Based Edible Film			Chick-pea Protein Based Edible Film		
	Thickness (mm)	Tensile Strength (MPa)	Elongation at Break (%)	Thickness (mm)	Tensile Strength (MPa)	Elongation at Break (%)	Thickness (mm)	Tensile Strength (MPa)	Elongation at Break (%)
1	0.11 ±0.02	1.67 ±0.05	48 ± 0.03	0.2 ± 0.02	0.34 ± 0.05	23 ± 0.03	0.19 ± 0.3	0.19± 0.7	13 ± 0.01
3	0.14 ±0.03	1.88 ±0.06	55 ± 0.05	0.26 ±0.03	0.68 ± 0.06	25 ± 0.05	0.23 ± 0.5	1.07± 0.3	45 ± 0.06
*5	0.16 ±0.06	2.09 ±0.01	64 ± 0.04	0.28 ±0.06	0.79 ± 0.01	65 ± 0.04	0.25 ± 0.3	1.31 ±0.5	62 ± 0.03
7	0.21 ±0.02	2.04 ±0.03	63 ± 0.01	0.32 ±0.02	0.81 ± 0.03	64 ± 0.01	0.27 ± 0.6	1.09 ±0.2	49 ± 0.09
9	0.24 ± 01	2.01 ± 0 02	60 ± 0.01	0.4 ± 0.01	1.11 ± 0.02	58 ± 0.01	0.03 ± 0.4	1.13±0.1	58 ± 0.05

*most suitable protein amount

Table 4.16 Effect of Amount of Glycerol on the Edible Film

Sr. No.	Amount of Glycerol (ml.)	Thickness (mm)	Tensile Strength (MPa)	Elongation at Break
1	1	0.11 ± 0.03	1.02 ± 0.5	32 ± 0.02
2	2	0.13 ± 0.04	1.06 ±0.04	45 ± 0.01
3	3	0.16 ± 0.06	2.09 ± 0.01	64 ± 0.04
4	*4	0.19 ± 0.03	2.78 ± 0.02	70 ± 0.03
5	5	0.23 ± 0.02	2.11 ± 0.01	65 ± 0.05

*most suitable tensile strength and elongation at break

Table 4.17 Effect of Dimension of Edible Film on the Film Thickness, Tensile Strength and Elongation at Break

Sr. No.	Area of Edible Film (cm^2)	Thickness mm	Tensile Strength	Elongation at Break
1	38	0.18 ± 0.02	2.14 ± 0.04	66 ± 0.07
2	60	0.16 ± 0.06	2.23 + 0.03	68 ± 0.05
3	88	0.11 ± 0.07	2.35 ± 0.06	71 ± 0.03
4	*120	0.06 ± 0.01	3.55 ± 0.02	75 ± 0.02
5	158	0.04 ± 0.04	3.11 ± 0.01	72 ± 0.01

*most suitable tensile strength and elongation at break

Table 4.18 Biodegradability of Bean Protein Isolate Based Edible Film

Initial Weight (g)	Weight Loss in Soil (^{0}/0 w/w)		Weight Loss in Water (^{0}/0 w/w)	
	After 4 days	After 8 days	After 4days	After 8 days
0.62	73.29 ± 0.07	92.26 ± 0.002	71.42 ± 0.03	90.13 ± 0.001
0.53	75.38 ± 0.03	96.33 ± 0.003	75.56 ± 0.01	94.76 ± 0.002
0.47	78.23 ± 0.06	97.10 ± 0.001	82.73 ± 0.05	95.71 ± 0.005
0.32	90.22 ± 0.02	100.00	94.21 ± 0.01	99.12
0.30	91.76 ± 0.05	100.00	97.67 ± 0.09	99.37

Table 4.19 Elemental Composition of Bean Protein Isolate Based Edible Film

Sr. No.	Elements		Composition (ppm)
1	Calcium	(Ca)	370000 + 0.03
2	Silicon	(Si)	180000 ± 0.02
3	Phosphorus	(S)	150000 ± 0.03
4	Potassium	(Fe)	110000 ± 0.05
5	Sulfur	(Zn)	110000 ± 0.03
6	Iron	(Cu)	70000 ± 0.05
7	Manganese	(Mn)	8000 ± 0.01
8	Titanium	(Ti)	8000 + 0.03
9	Zinc	(Zn)	7000 ± 0.01
10	Copper	(Cu)	5000 ± 0.02

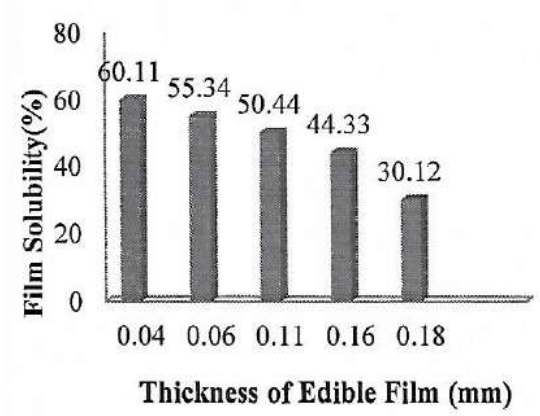

Figure 4.7 Effect of Thickness on the Film Solubility of Edible Film

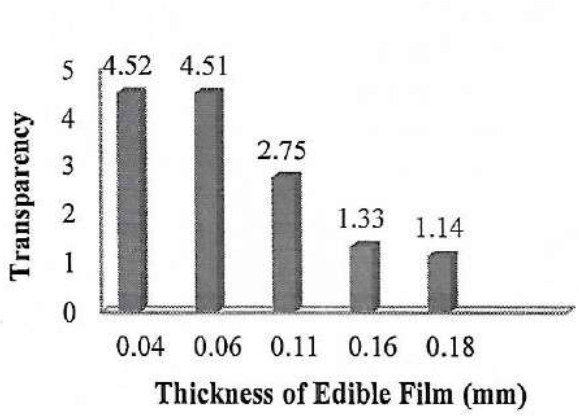

Figure 4.8 Effect of Thickness on the Transparency of Edible Film

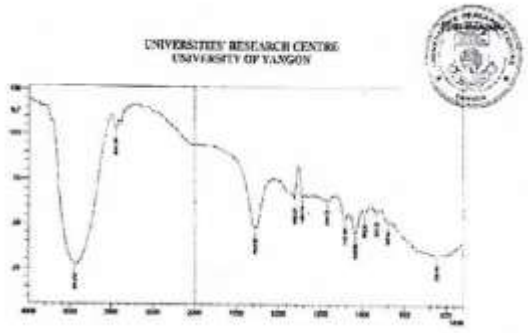

Figure 4.9 FT-IR Spectrum of Bean Protein Based Edible Film

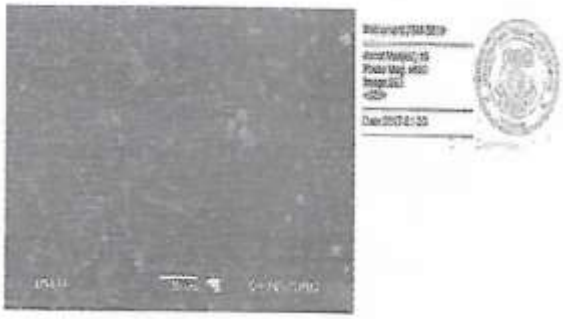

Figure 4.10 Surface Morphology of Bean Protein Based Edible Film

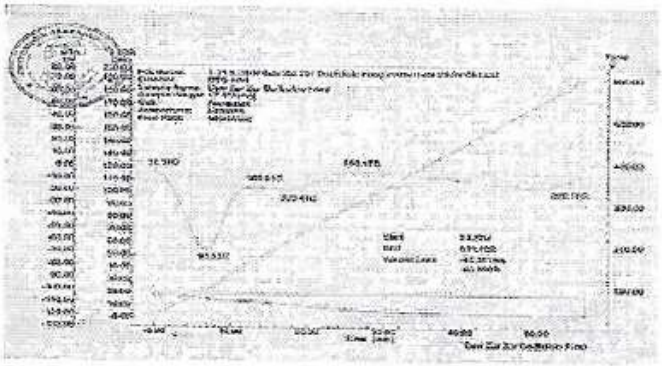

Figure 4.11 TG-DTA of Bean Protein Based Edible Film

Figure 4.12 Bean Protein Tablet

Figure 4.13 Bean Protein Based Edible Film

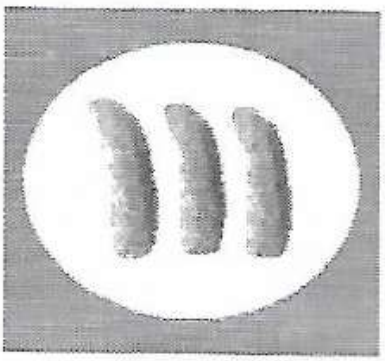

Figure 4.14 Chicken Sausages Wrapped in Edible Film

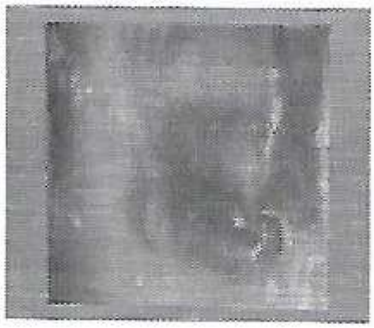

Figure 4.15 Carrots Wrapped in Edible Film

Figure 4.16 Oranges Wrapped in Edible Film

Figure 4.17 Mustard Wrapped in Edible Flim

Table 4.20 Characteristics of Prepared Chicken Sausages Using Bean Protein Isolate as Meat Extender and Casing

Sr. No.	Characteristics	Different Amount of Bean Protein Isolate in Sausages (g)					Commercial Sausages (CP Grade)
		1	**3**	**5**	**7***	**9**	
1	pH	5.9	6.2	6.5	6.7	6.8	6.1
2	Moisture content % w/w	6.5	6.3	5.8	5.5	5.4	7.1
3	Cooking loss	18.4	17.2	15.8	12.5	12.2	14.2
4	Cooking yield	79.2	80.4	82.7	84.3	85.4	78.22
5	Change in diameter %	7.2	6.7	5.5	4.8	4.7	6.8
6	Change in length	8.2	7.6	5.4	6.1	6.0	7.2
7	Total plate count cfu/	3×10^2	2×10^2	2×10^2	1×10^2	1×10^2	-
8	Shelf-life month	2	2	2	2	2	-

*most suitable protein amount

Table 4.21 Sensory Evaluation of Chicken Sausages Assessed by 9-point Hedonic Scale Rating Test

Sr. No.	Sensory Property	Different Amount of Protein Isolate (g)				
		1	**3**	**5**	***7**	9
1	Juiciness	7	7.1	8.2	8.5	8.6
2	Tenderness	5.9	6.3	7.4	7.9	8
3	Color	6	7.2	8.4	8.7	8.9
4	Odor	6.3	5.9	7.2	7.3	7.4
5	Flavor	5.5	7.5	7.6	8.1	8.2
6	Total Score	30.7	34	38.8	40.5	41.1
7	Overall acceptability	6.1	6.8	7.8	8.1	8.2

Conclusion

Myanma beans, one of the most crucial agricultural commodity, are widely cultivated in the lower part of Myanmar, central plain areas and eastern part of country. Because of high protein content, they have been used as an inexpensive protein source in the diets due to the health and nutrition conscience population. Firstly, bean flour (mung bean, lentil and chick-pea) respectively could be effectively defatted by using the combination of soaking in ethanol solution followed by soxhlet extraction because high fat content may interfere protein isolation and protein may be denatured. So, the fat should be removed to isolate the protein. It was found that the highest fat removal of 46.43 ± 0.03 %, the highest protein content of 51.37 ± 0.02 %, has been achieved by the combined bulk soaking and soxhlet extraction of defatted mung bean flour. The highest isolation of protein was related to the highest fiber removal and starch removal from defatted flour by using isoelectric precipitation. In the preparation of protein isolate, the highest fiber removal of 54.54 ± 0.05 %, starch removal of 69.74 ± 0.07 % and highest protein content 94.47 ± 0.02 % at pH 4.5 was observed for mung bean protein isolate. It was found that the lowest protein solubility and emulsion capacity were observed at pH 4.5 which was the isoelectric point of pH value. The foam developed by bean protein isolate was the most stable after staying for 150 min. Having their excellent functional properties, bean protein isolate can be further utilized as supplements for various food products. Bean protein has not only has high nutritional value but also good source for edible film formation and, therefore, application of the film can be suggested in food industries. 120 cm^2 dimension of bean protein based edible film gave the highest tensile strength and elongation at break. Bean protein isolate based edible film is transparent, dissolvable and has substantial mechanical strength to withstand stress during handling. In biodegradation study, it was clearly seen that biodegradable film was completely degraded within 8 days. Based on findings, bean protein isolate film shows promise as potential material for use in designing edible, biodegradable packaging for various food functions. The use of bean protein isolate at concentrations of 1%, 3%, 5%, 7% and 9% had proved to be effective as a meat extender in producing high quality chicken sausages. Quality criteria such as pH, moisture content and total bacterial count of prepared chicken sausage were evaluated during storage at 4 ^{o}c and it could be concluded that 7 % bean protein isolate based sausage improved the cooking characteristics such as cooking loss, cooking yield, change in diameter and change in length and also positive effects on the sensory characteristics of the product. Its nutritive value and attractiveness are also magnified by packing in the edible film.

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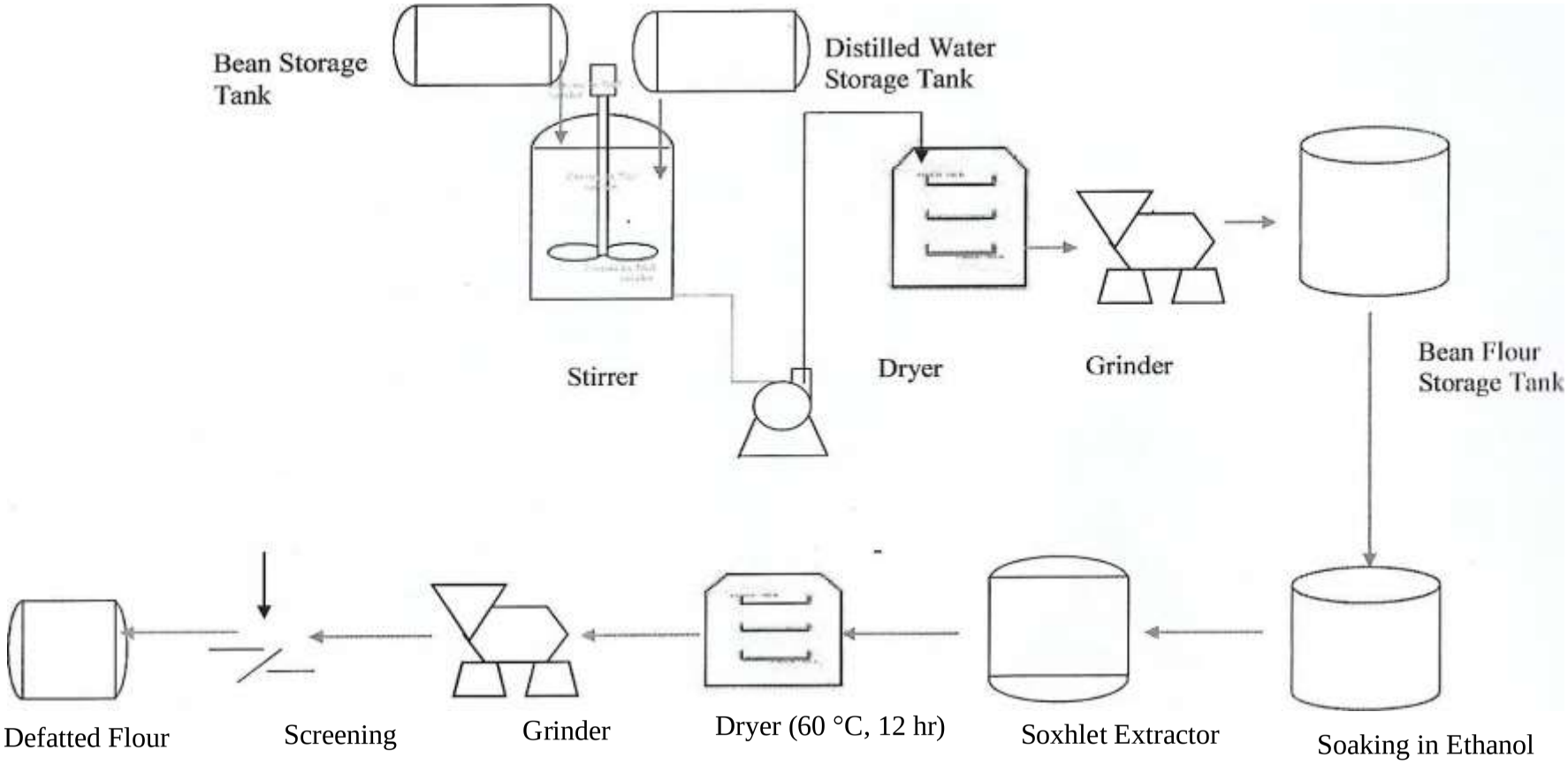

Figure A : Process Flow Diagram for the Production of Defatted Flour

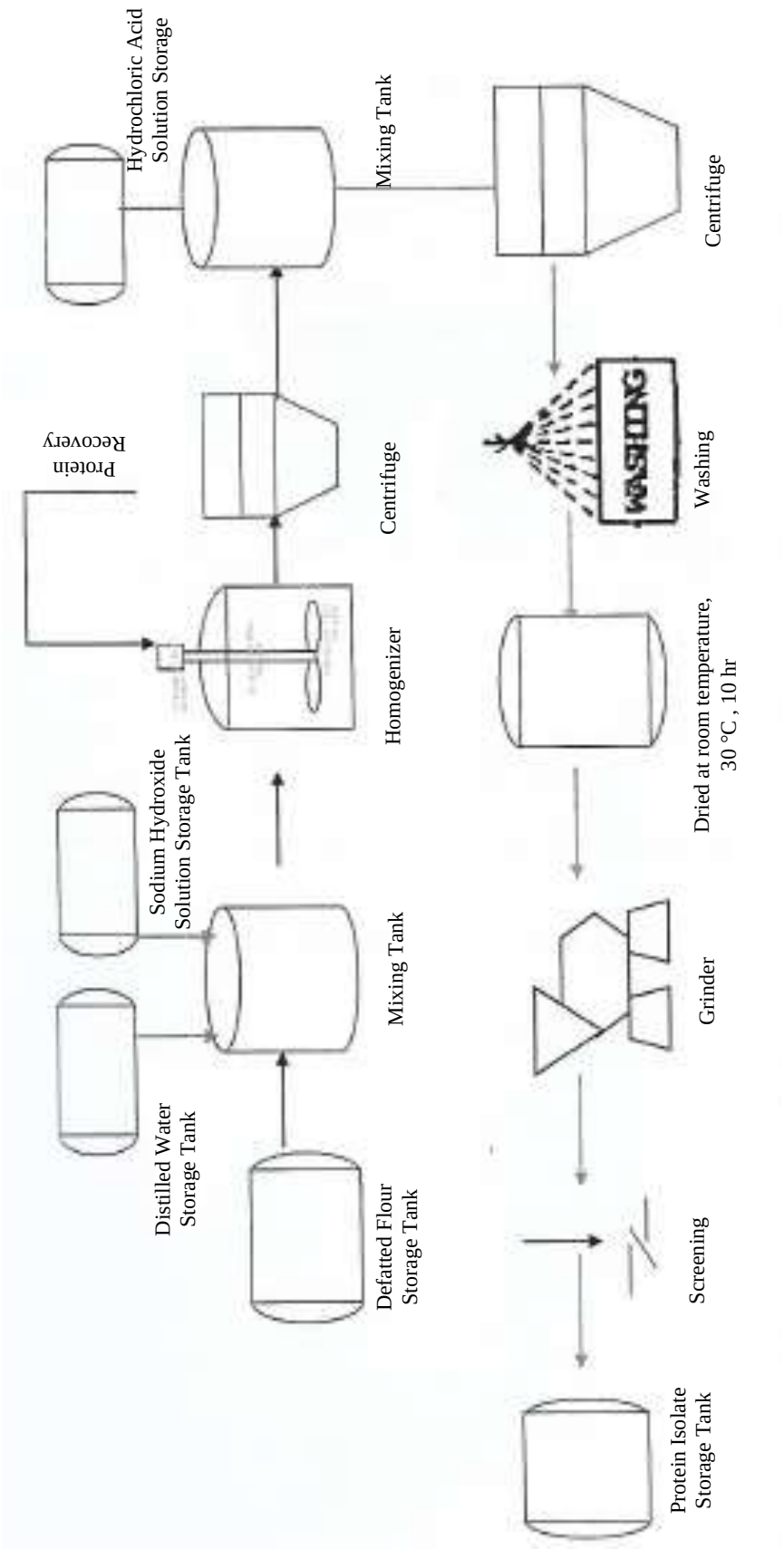

Figure B: Process Flow Diagram for the Production of Protein Isolate from Defatted Flour

PREPARATION AND CHARACTERIZATION OF SnO_2 NANOFIBER AND THIN FILM PHOTOELECTRODES FOR DYE SENSITIZED SOLAR CELLS

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PREPARATION AND CHARACTERIZATION OF SnO_2 ANOFIBER AND THIN FILM PHOTOELECTRODES FOR DYE SENSITIZED SOLAR CELLS

Zayar Pyae Phyo Aung[1]

Abstract

Nanocrystalline tin oxide (SnO_2) powders have been synthesized by a direct precipitation from an aqueous solution. The resulting powder were calcined at 650 ˚C for 6 h. The crystallite size and lattice parameters of SnO_2 nanocrystalline powder was observed by X-ray diffraction (XRD). The XRD analysis revealed that SnO_2 nanoparticle was phase pure and all materials exhibited a tetragonal rutile structure. The nanostructure was confirmed by field emission scanning electron microscope (FESEM). UV-visible spectrometer was used to measure the optical absorption properties of SnO_2 nanopowders and the optical energy band gap was 3.82 eV. SnO_2 nanofibers were deposited on ITO (Indium Tin Oxide) by home-made electrospinning with vertical experimental set up. This home-made electrospinng set-up consists of three components such as home-made high voltage power supply, syringe and collector. The electrospinning was under taken by applying a DC voltage of 20 kV from fly-back transformer based home-made high voltage power supply to the tip of a syringe. The ITO (Indium Tin Oxide) coated glass substrate was used as a collector and maintaining the tip to collector distance (TCD) of 5 cm, 7 cm, 10 cm and 12 cm. The spinning or running time interval was set to 5 h. The green nanofibers were annealed at 600˚C for 2 h. The nanofibers treated at 600˚C was examined by field emission scanning electron microscope (FESEM) and atomic force microscopy (AFM). The FESEM and AFM showed cylindrical fibers with diameter in the range of 47 – 100 nm. The films were deposited by spin coating method and heat treated at 400°C, 500°C and 600°C. Microstructural analysis was carried out by field scanning electron microscope (FESEM). Next, graphene oxide was prepared by Hummer method for counter electrode and they were characterized by X-ray diffraction (XRD), fourier transform infrared spectroscopy (FTIR) and field emission scanning electron microscope (FESEM). The XRD result showed that the interplanar distances “d” were 3.334 Å for graphite and 7.992 Å for graphene oxide. The natural dye solution from grass was prepared by soxhlet extraction method. According to the UV-visible analysis, the strongest absorption peak was found at the wavelength of 671.50 nm. Both SnO_2 fibers and SnO_2 thin films were sensitized with natural dye solution and assembled into DSSCs. After that, the solar cell performance of DSSC with nanofiber was measured and compared to those of DSSCs with SnO_2 thin films. According to the I-V measurement, the efficiency of SnO_2 nanofibers based DSSCs were greater than that of SnO_2 thin films based DSSCs. The SnO_2 nanofiers based DSSC of TCD 12 cm gave the best efficiency and it was 2.71 %. So, the results show that SnO_2 and natural dye is a promising application in the preparation of dye sensitized solar cell.

Introduction

Dye-sensitized solar cells (DSSCs) have attracted growing interest as alternative devices to traditional silicon solar cells because they have lower fabrication costs (Abdul Kariem Arof & Teo Li Ping (2017)). It is a very promising candidate for next-generation solar cells due to the prospects of low cost and high efficiency (Asama. N. Naje et al (2013). A DSSC consists of a porous wide band gap semiconductor thin film layer like (TiO_2, ZnO, SnO_2) coated on a fluorine-doped tin oxide (FTO) photoanode electrode, a dye, a platinum (Pt) thin film counter electrode and an electrolyte normally containing I−/I− 3 redox couple (E. Suresh et al (2016). The most characteristic feature of the DSSC relative to other types of solar cells is the use of a dye. The sensitizer is also playing an important role to harvest the photons and all the parts have relevance in the photovoltaic properties (Brian O'Regan et al. (1991)). SnO_2 based DSSCs has relatively low open circuit

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voltages because of their high recombination kinetics with electrolytes (ACS Material Blog (2017)). In addition, they reduce the conversion efficiency. In recent years, various morphologies of SnO_2 have been investigated to increase the photo conversion efficiency of SnO_2-based DSSCs (HATEM S. EL-GHAMRI et al (2014)). The main drawbacks of SnO_2-based DSSCs are the high recombination rate and poor electron transfer efficiency for increasing the energy conversion efficiency (F.Y. Ban et al (2012)). One of the best ways to solve this problem is making 1 D structure materials (Ganesh E. Patil et al (2012) &. Jiawei Gong, Hui Qiao (2015)). Research on the creation of nanofibers has centered on the fabrication of the fibers using different techniques. They are thermal evaporation, Drawing, Template synthesis, phase separation and electrospinning. (Jiawei Gong, Hui Qiao (2015) & Rajesh Vasita et al (2006)). Of the given technique's electrospinning has the advantages of fibers with diameters size of nanometer to few microns, relatively inexpensive technique and high aspect ratio, enhanced mechanical properties (Sofyan A. Taya et al (2013) & Xiaomin Shi et al (2015)). Electrospinning is the only process in which we can effectively control the dimension of the fiber during the synthesis (Suriati Suhaimi1 et al (2015) & T.F. Stoica, T.A. Stoica (2000)). So, we can optimize the size of the fiber easily by this technique. Recently, one dimensional nanomaterial like nanotubes, nanowires and nanofibers have been replaced the place of the nanoparticles in DSSCs because of its unique properties.

Aim

DSSC's are a smart technology to provide clean energy from the sun, help minimize electricity cost and surface usage. Research done on DSSC's generally and this work particularly focus on the improvement of the materials used principally the oxide and dye. The techniques used in both research and manufacturing of DSSC's are ethical and sustainable. In other means, no harm (including testing) is done on humans or animals. Neither toxic chemicals are used in research nor manufacturing and no chemical waste is thrown in nature. There is no intensive use nor depletion of natural resources. There are two main objectives in this research. The first one is to produce the nanofibers with low cost home-made electrospinning device. The second one is to get the maximum efficiency from one-dimension nanomaterials at the lowest cost and longest time. Moreover, this research is the evidence for the changing of nanoparticle (0 D) to nanofiber (1 D) is one of the most promising way to enhance the performance of dye sensitized solar cells.

Experimental Procedure

Sample Preparation of SnO_2 Nanopowder

In this research, Stannous chloride dehydrate ($SnCl_2.2H_2O$) was used as starting materials. Distilled water was used as a solvent. SnO_2 nanopowders have been prepared by using precipitation method. SnO_2 nanopowders were prepared by means of dissolving of 2 g (0.1 M) stannous chloride dehydrate ($SnCl_2.2H_2O$) in 100 ml distilled water. 10% ammonium hydroxide was slowly added to the solution for complete precipitation of tin hydroxide in the pH range 7.5 - 9. Then the solution was put into thermostat water bath, in which the temperature was kept about 80 ˚C, for 15 minutes until white depositions came out. Then the precipitate was centrifuged and washed several times (pH =7) with distilled water to reduce the amount of ammonium chloride. The resulting gels was filtered and dried at 100 ˚C for 3 h. The obtained powder was collected and grounded in an agate mortar and it is referred "as – prepared". The color of the as-prepared sample is gray. Finally, the as-prepared sample was heated in a muffle furnace at 650 ˚C for 6 h in an atmosphere, then the color turned into white. The obtained sample was characterized by X-ray powder diffraction (XRD)

using (Rigaku RINT 2000). Field emission scanning electron microscopy (FESEM) was employed for morphological study using ZIESS (MERLIN).

Cleaning of the Substrate

In the present study ITO/glass, cut into 1×1 cm square plates have been used as substrates. Prior to deposition the substrates are subjected to the following cleaning process to remove the unwanted impurities normally present on the surfaces of the glass plates exposed to the atmosphere.

1. The glass substrates are washed in soap solution by scrubbing the surfaces with a cotton swab dipped in liquid soap.
2. The glass slides are then rinsed thoroughly in deionized water.
3. Then the slides are soaked in HCl acid and kept in room temperature for about two hours.
4. Finally, the substrates are rinsed thoroughly in deionized water and dried at 100°C for one hour in an oven.

Preparation of SnO_2 Paste and Spin Coating of Tin Oxide Films for Photo Electrodes

The various steps involved in obtaining Tin Oxide thin films using the spin coating technique. The paste has been prepared by 2 g of SnO_2 powder was dissolved into the 100 ml of ethanol. The mixture was stirred by magnetic stirrer for 2 h. The solution was then ultrasonicated for 4 h to reduce particle size. After sonication, the paste was ready to use as spinning paste. After that the film were deposited on ITO/glass substrate. After spin coating at room temperature, and at a speed of 3000 rpm for 30 s, the coated films were dried 15 minutes at 150 ˚C. The formation of ITO films by removing the organic component followed by structural rearrangement was performed by annealing the coated films for one hour at the temperature of 400 ˚C, 500 ˚C and 600 ˚C. The structural properties of the films were measured by field emission scanning electron microscope (FESEM).

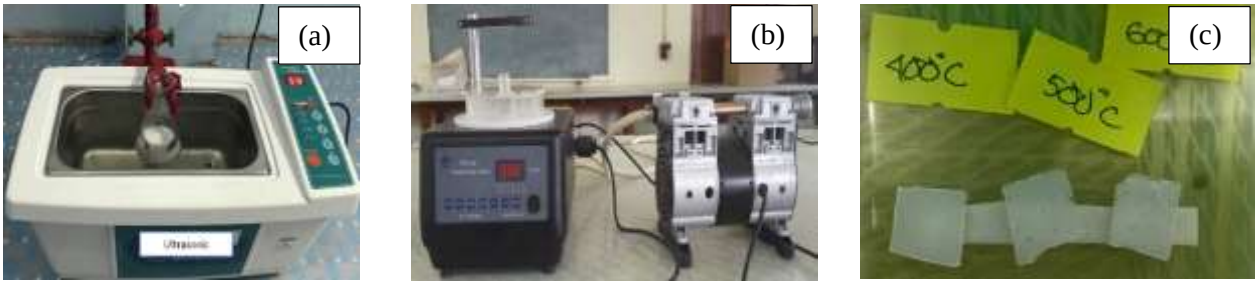


Figure 1 (a) Ultrasonication (b) spin coating machine (c) SnO_2 films

Low Cost Home-made Electrospinning Set-up for SnO_2 Nanofiber

Electrospinning is a very simple technique that can be used to produce nanofibers under the influence of a high electric field. This home-made electrospinnng set-up consists three components. They are home-made high voltage power supply, syringe (emitter) and collector plate. The positive terminal of the DC source was connected with a needle and the Al-substrate (collector) was connected with the negative terminal to ground it. When the voltage was applied a stream of solution came out through the needle which was subdivided into a number of nano to submicron sized jets and were deposited in the form of nanofibers on the collector pate.

Design and Construction of Home-made High Voltage Power Supply

The power supply is constructed to obtain large output voltages (dc), at low currents. The output can be adjusted using the potentiometer on the outside of the box. Here are the important specifications.

Output voltage range: 1000 – 20000 V DC, Maximum output current: 20 mA, Input voltage: 210 - 250 V AC, Input current: 0.5-1 Amperes.

This home-made HV power supply was composed of five sections. the block diagram, circuit diagram and the photo of homemade high voltage power supply are shown in figure 2, 3 and 4.

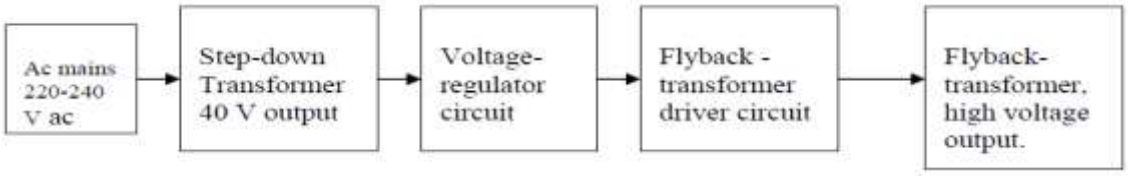


Figure 2 The block diagram for home-made high voltage power supply

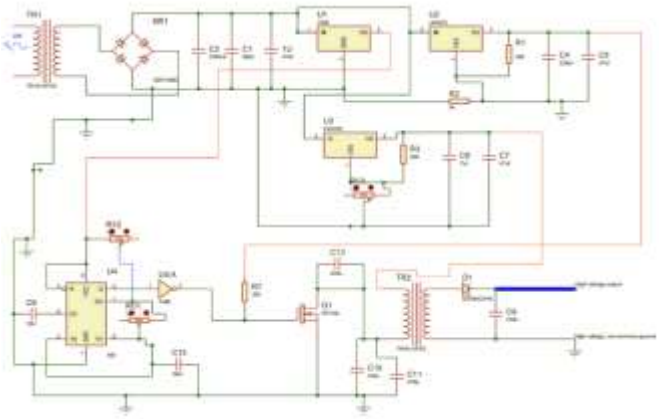


Figure 3 The circuit diagram of HV power supply

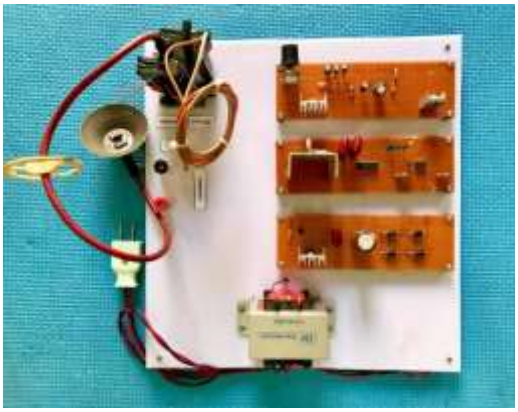


Figure 4 Home-made high voltage power supply

Sample Preparation of SnO_2 Nanofiber

In this study, tin dioxide (SnO_2), Poly Vinyl Alcohol (PVA) and distilled water were chosen as the starting chemicals and solvent. SnO2 nanofibers were prepared by sol-gel process. 1 g of SnO2 was dissolved in 2 ml of acetic acid with constant stirring for 10 min to obtain a clear solution of tin acetate in the pH range 1-2. This solution was mixed with 4 ml of 10 % PVA solution. The solution was stirred for 4 h by a magnetic stirrer and a viscous sol-gel was obtained. Nearly 5 ml of the viscous solution was taken in a 20 ml syringe. The distance of 5 cm, 7 cm, 10 cm and 12 cm were maintained between the collector plate and the tip of the needle. Al-substrate was then struck on the collector. When the voltage was applied a stream of solution came out through the needle which was subdivided into a number of nano to submicron sized jets and were deposited in the form of nanofibers on the collector pate. The green nanofibers were calcined at 600 ˚C for 2 h. A sketch and photo electronspinning set up is shown in figure 5 (a) and figure 5 (b). The electrospinning conditions are mentioned in table 1. The morphology of the fibers was measured by field emission scanning electron microscope (FESEM) and atomic force microscope (AFM).

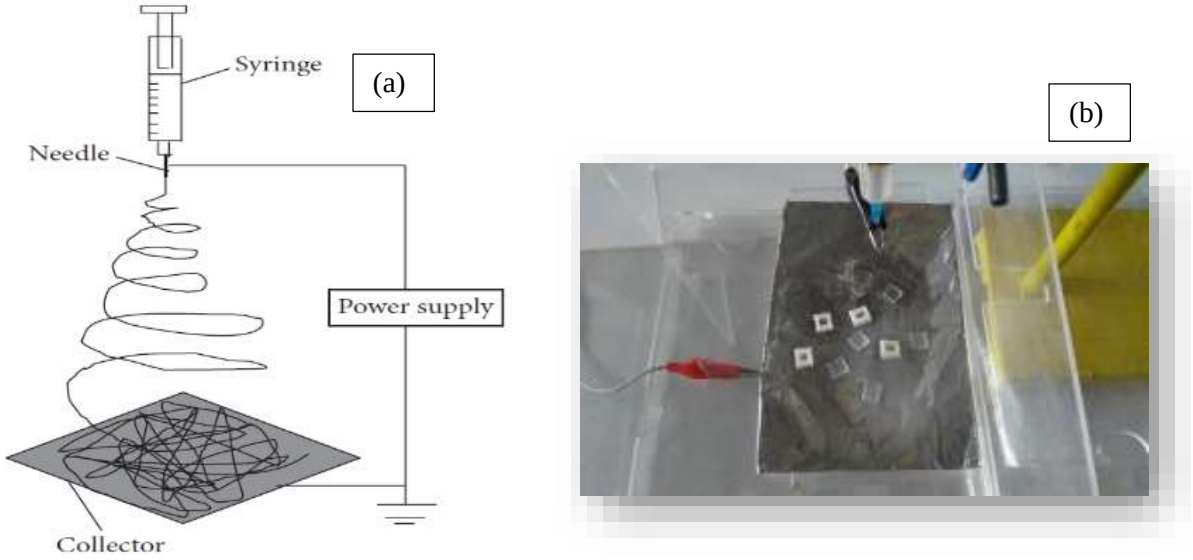


Figure 5 (a) Schematic drawing and (b) photo of the electrospinning process set up

Table 1 The elctrospinning conditions of SnO_2 nanofibers

Syringe capacity	**20 ml**
Tip to collector distance (TCD)	5 cm, 7 cm, 10 cm and 12 cm
Voltage	20 kV
Annealing temperature	600 ˚C
Annealing time	2 h

Preparation of Graphene Oxide (GO) Counter Electrode

Graphene oxide was synthesized from natural graphite by Hummers method. Firstly, Graphite (5 g) and $NaNO_3$ (2.5 g) were mixed into the 500 mL flask. Then, 120 mL of H_2SO_4 was put into the beaker and the mixture was stirred for 30 min within an ice bath. Under vigorous stirring, 15 g of potassium permanganate was slowly added to the suspension. The mixture was stirred at room temperature overnight. Then, 150 ml of H_2O was slowly added still under vigorous stirring. The reaction temperature was rapidly increased to 98 °C with effervescence, and the color changed into yellow. The diluted suspension was stirred at 98 °C for one hour. Then, 50 mL of H_2O_2 was added to the mixture. The mixture was washed by rinsing and centrifugation with 5% HCl then deionized (DI) water for several times in the pH range between 5-7. Finally, the product was dried at 60 ˚C for 24 h in a vacuum oven. After drying under vacuum, solid graphene oxide (GO) was obtained. The resulting graphene oxide powder was ground into a fine powder and dissolved into ethanol to become solution. And then the graphene oxide solution was deposited onto the ITO glass substrate by spin coater at a speed of 3000 rpm for 30 s and heat treated at 80 ˚C for 24 h. The graphene oxide powder was analyzed by XRD, FTIR and SEM.

Figure 6 Graphene Oxide counter electrode

Preparation of Natural Dye-Sensitizer

The grass from 16˚ 52’ 59.69” N 97˚ 37’ 51.02” E was used as a dye in this work. Firstly, the grass was washed with deionized water and dried in dark place at room temperature for about 3 months. After drying, the grass was crushed into small pieces using mortar. Then, dried small grass parts were put into thistle of soxhlet extractor and ethanol was used as solvent. Temperature of the instrument was maintained well under boiling point of the ethanol. Several cycles of solvent were run so as to extract all the compounds from plant parts. Next, the ethanol from dye solution was removed by distillation. Finally, the pure natural dye solution (pH=6.67) was obtained and it was ready to be used as a natural dye sensitizer in DSSCs.

Figure 7 The image of grass & its position form Google earth

Figure 8 Soxhlet extraction

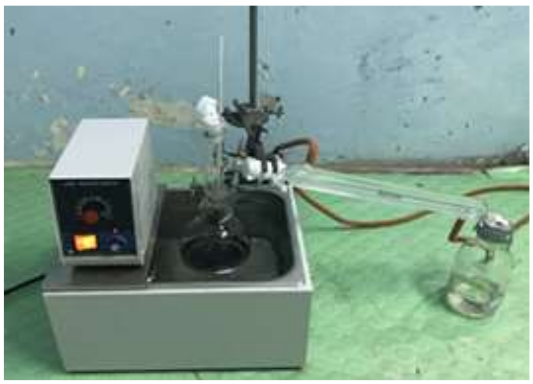


Figure 9 Dye extraction with soxhlet extractor

Figure 10 pH measurment

DSSC Assembling

SnO_2 thin films and SnO_2 nanofibers films were immersed into the dye solution for 12 h. All the dye loaded photo electrodes were sandwich with graphene oxide (GO) counter electrodes by double clips. Three drops of iodide solution were added at the end of the electrode and the solutions were spread over the entire electrode. Then, the remaining iodide solution were wiped off using cotton swab soaked with alcohol. After that, a tester with crocodile clip were attached at both ends of the electrode. Now, the DSSCs were ready. The fabricated solar cells were characterized by the current-voltage characteristic.

Figure 11 DSSCs with alligator clips

Results and Discussion

XRD Analysis of SnO_2 Nanopowder

X-ray diffraction is used to determine crystallinity of polymeric materials. XRD uses the total X-ray scattering both the crystalline and amorphous phases to determine the crystallinity. The phase analysis of powder was determined by using an X-ray Diffractometer (Rigaku RINT 2000). XRD was performed using monochromatic CuKα radiation (λ= 1.54056 Å) operated at 40kV (tube voltage) and 40mA (tube current). Sample was scanned from 10° to 70° in diffraction angle 2θ with a step-size of 0.02°.

According to the XRD analysis, pure tin oxide nanoparticles were matched with standard library of PDF 77-0447 cassiterite tin oxide. The X-ray diffraction (XRD) pattern of SnO_2 nanoparticles powder from $SnCl_2.2H_2O$ is shown on figure 12. The peaks at 2θ values of 26.588°,

33.848°, 37.878° and 51.720° can be associated with (110), (101), (200) and (211) respectively. All of the peaks can be indexed to be pure tin oxide structure of tetragonal due to the lattice parameters agreement with the literature. The average crystallite size is 27.49 nm. The lattice distortion (or) lattice strain peaks indicate the good crystalline nature of the powder. The crystallite size (D) were calculated based upon on the all diffraction peak's (main peak's) broadening in the XRD pattern using the Debye Scherrer equation. The value of FWHM, Bragg angle (θ) and crystallite size of observed planes of pure SnO_2 powder was listed in table 2. The lattice parameters and lattice distortion for SnO_2 powder was expressed and compared with standard data to confirm the structure of SnO_2 as listed in table 2.

Table 2 Average crystallite size of pure SnO_2 powder from $SnCl_2.2H_2O$ for all identified peaks at 650 °C

No.	Peak	FWHM (deg)	2-Theta(deg)	Crystallite size (nm)
1	(1 1 0)	0.48	26.58	16.90
2	(1 0 1)	0.27	33.84	33.62
3	(2 0 0)	0.27	37.87	34.00
4	(2 1 1)	0.34	51.72	25.44
Average crystallite size				27.49

Table 3 Lattice parameters (a & c) and lattice distortion c/a for SnO_2 powder

	Lattic parameter		c/a
	a(Å)	c(Å)	
$SnCl_2.2H_2O$	4.739	3.193	0.673
Standard	4.737	3.185	0.672

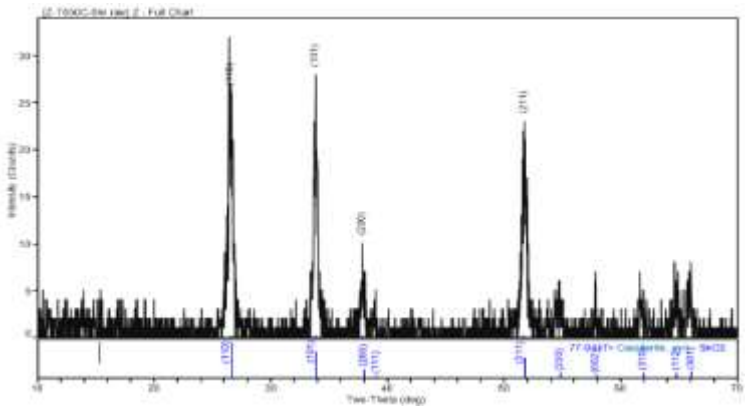


Figure 12 XRD diffractorgram of tin oxide nanopowder

XRD analysis of Graphene Oxide (GO)

In Figure 13 (a) and 13 (b), the X-ray diffraction spectrograms were compared for graphite and graphene oxide. The d = 3.334 Å diffraction peak of natural graphite occurs near the location where 2θ = 26˚; it can be seen that the peak is sharp and high, showing high crystallinity. In the spectrogram for graphite oxide, the diffraction peak of graphite crystal disappears and, in its place,

the diffraction peak (001) of graphene oxide occurs. And well matched with standard library file (GO)-03-065-1528. It can be seen that the interlayer distance is increased clearly from 3.354 Å for graphite to 7.992 Å for graphene oxide. This is caused by the large number of polar groups generated between the layers of graphite during oxidation [6]. The other possibility for the increasing in interplanar distance of GO is due to the existence of oxygen functional groups [9].

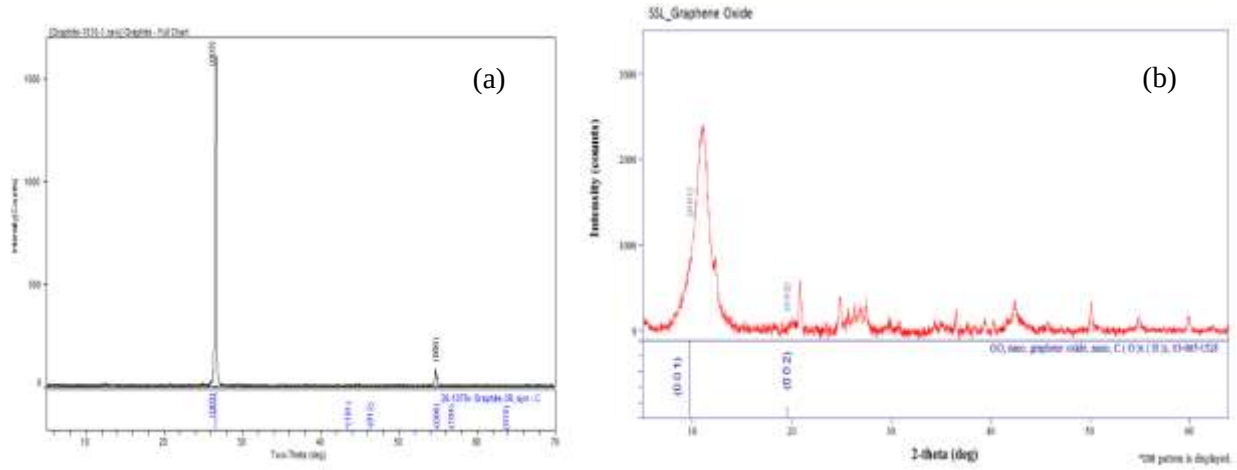


Figure 13 (a) XRD pattern of graphite and (b) graphene oxide (GO)

FTIR Analysis of Graphene Oxide (GO)

FT-IR spectroscopy is a power full technique to characterize the presence of different functional groups in graphene oxide including oxygen containing functional groups. FT-IR spectrum was recorded and the spectrum of GO obtained confirmed the successful oxidation of the graphite (figure 14). Some functional groups such as O—H, C—OH, COOH and C—O were observed. The absorption peaks corresponding to O—H stretching (a peak ∼3400 cm−1) which is superimposed on the OH stretch of carboxylic acid, is due to the presence of absorbed water molecules and alcohol groups. This supports the fact that GO is a highly absorptive material, as verified by its ability to become a gel-like solution [9]. The peak around 1619 cm−1is attributed to C=C stretches from unoxidized graphitic domain. The peak at around 1720 cm−1is attributed to C=O stretch of carboxyl group [56]. 1095 cm−1is attributed to C—O stretching vibrations of C—O—C . Finally, the absorption peaks at 1,385 cm^{-1} and 1,110 cm^{-1} are caused by the vibration of C—O of carboxylic acid and the stretching vibration of C—OH of alcohol, respectively. The existence of these oxygen-containing groups' reveals that the graphite has been oxidized [11].

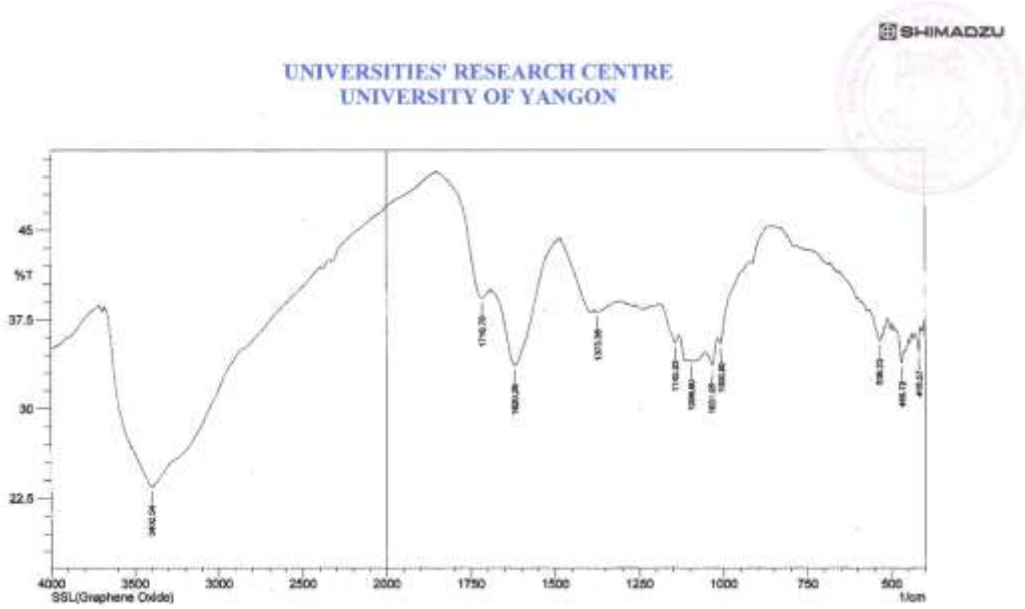


Figure 14 FTIR spectrum for graphene oxide (GO)

UV-Visible Analysis of SnO_2 Nanopowder

The UV-Vis spectra of SnO_2 powder was recorded with respect to the glass substrate placed in the reference beam using beam spectrometer in the range 190 to 1100 nm. The absorption spectrum of SnO_2 deposited on glass substrate is shown in figure 15 (a). The figure shows high absorption coefficient in the UV region. It's transparent coefficient also in the UV region. The optical band energy (Eg) of the semiconductor is calculated from the relation.

$$\alpha\, h\upsilon = A\,(h\upsilon - Eg)^n$$

where α is the absorption coefficient, A is a constant (independent from υ), n is the exponent that depends upon the quantum selection rules for the particular material, h is the planck's constant and Eg the energy band gap. A plot of $(\alpha h\upsilon)^2$ versus hυ shows intermediate linear region, the extrapolation of the linear part can be used to calculated the Eg from intersect with hυ axis as shown in figure 15 (b). The resultant values of Eg for SnO_2 is found to be about 3.82 eV. The value may be related to the formation of nanostructures of SnO_2 and the bulk SnO_2, this value shows a good agreement with the values published by other researchers.

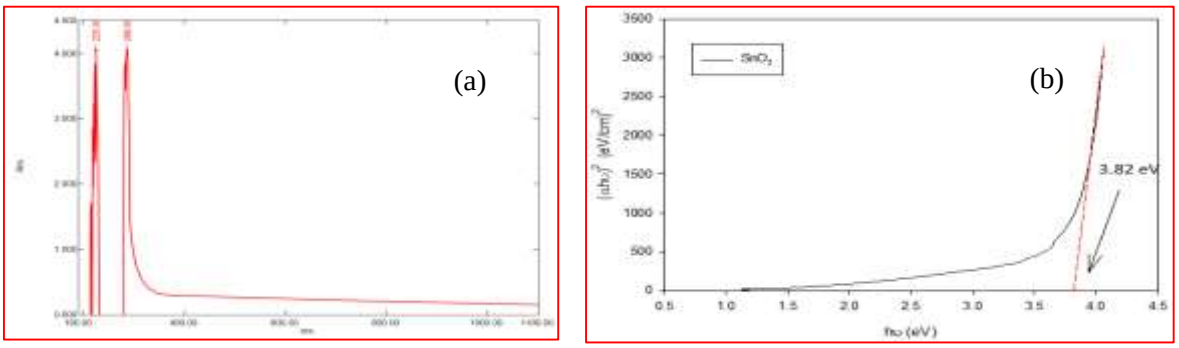


Figure 15 (a) The absorption spectrum (b) Plot of $(\alpha h\upsilon)^2$ vs. photon energy (hυ) for SnO_2

UV-Visible Analysis of Natural Dye Solution

The absorption spectrum of grass dye was obtained from UV-Vis spectroscopy. The wavelength range of spectrum between 400 nm and 800 nm. In this absorption spectrum, it was observed that the wide range absorption peaks and all of absorption peaks were within visible region. The strongest absorption peak was found at the wavelength of 671.50 nm and it was contributed that chlorophyll a. In accordance with the Beer-Lambert law that the absorbance value (A) inversely proportional to the value of transmittance (T) and is proportional to the concentration of the solution (C). The maximum absorbance is obtained in this research for 4.00. It shows the greater the concentration of the extract of grass in the solution, the greater the absorbance values and the smaller the transmittance values. Because the chlorophyll content affects the absorbance value of sample's concentration. The absorbance spectrum of extract grass was described in figure 16. Peak absorbance at a wavelength λ= 469 nm with absorbance at 4.00 and λ= 671 nm and with absorbance of 2.82. So, the extract dye from the grass has a greater efficiency when applied to dye-sensitized solar cells (DSSCs).

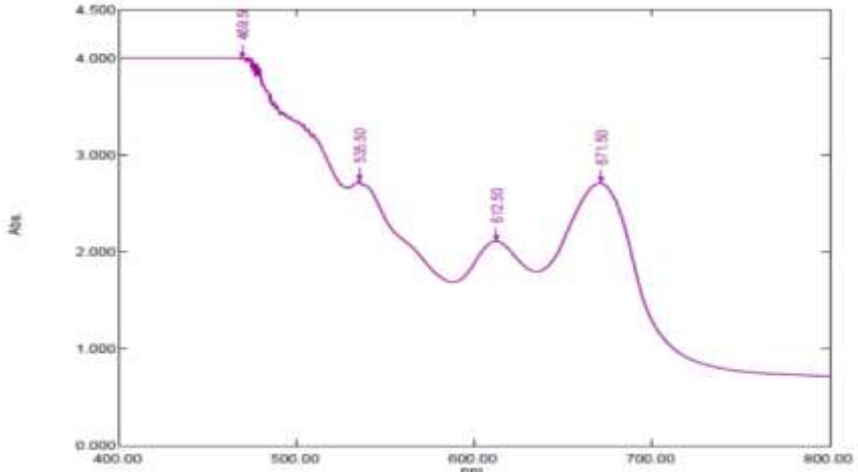


Figure 16 UV-Vis absorbance spectra of grass dye solution with ethanol

FESEM analysis of SnO_2 Nanopowder and Films

The SnO_2 powder was obtained from directed precipitation method. Figure 17 (a) shows the FESEM analysis of the SnO_2 powder. The grain sizes were calculated by using well known bar code system. Bar code size was 1 µm. According to the calculation the grain size is 80 nm – 120 nm. The powders morphology was spherical in shape and then the surface was rough. The FESEM images of SnO_2 films for 400 ˚C, 500 ˚C and 600 ˚C were shown in Figure 17 (b), 17 (c) and17 (d). According to the FESEM images the sizes of the grain are non-uniform. The various sizes of particles spread out on the surface of the film. The surface structures of the films are not very different. Among of them, the surface of the film of 400 ˚C is the most uniform in all films. So, in this case, we can consider the surface structure of the films do not depend upon the changing of calcination temperature. The average grain sizes of SnO_2 films for all temperature are 75 nm – 300 nm respectively.

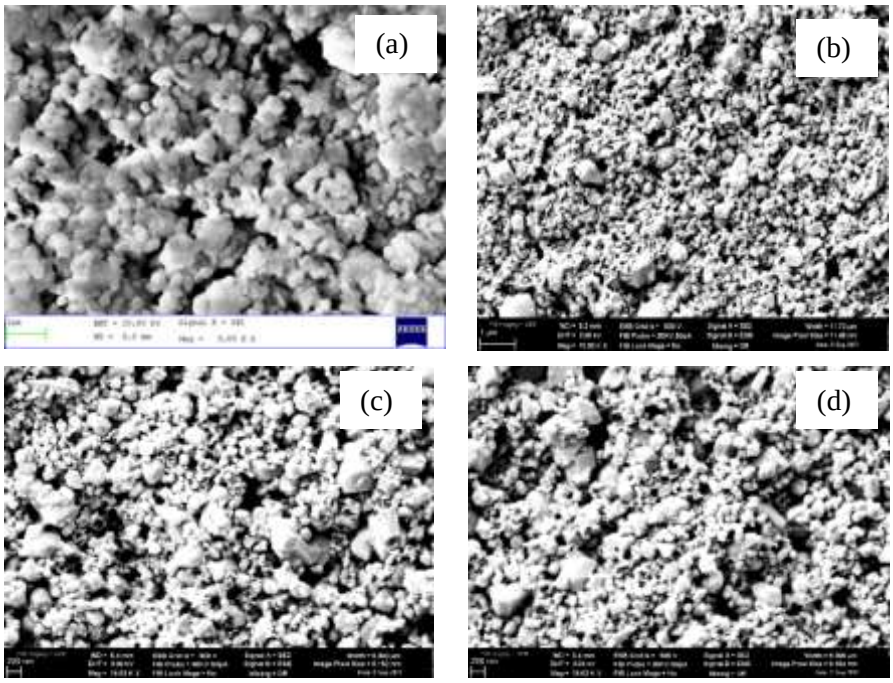


Figure 17 (a) FESEM images of SnO_2 nanopowder, and FESEM images of SnO_2 film of (b) 400 ˚C (c) 500 ˚C, (d) 600 ˚C

FESEM Analysis of Graphene Oxide (GO)

The graphene oxide (GO) was synthesized by Hammer's method and the SEM micrographs of synthesized GO of different scale bars were given in figures 18 (a) and 18 (b). From the figure, it can be observed that graphene oxide has layered structure, which affords ultrathin and homogeneous graphene sheet. Such sheets are folded or continuous at times and it is possible to distinguish the edges of individual sheets, including kinked and wrinkled areas. Moreover, the GO sample contain several layers of aggregated and square-shaped crumpled sheets closely associated with each other to form a continuous conducting network. The edges of the GO sheets become crumpled, folded, and closely restacked, and the surface of GO exhibits a soft carpet-like morphology, possibly because of the presence of residual H_2O molecules and hydroxyl groups.

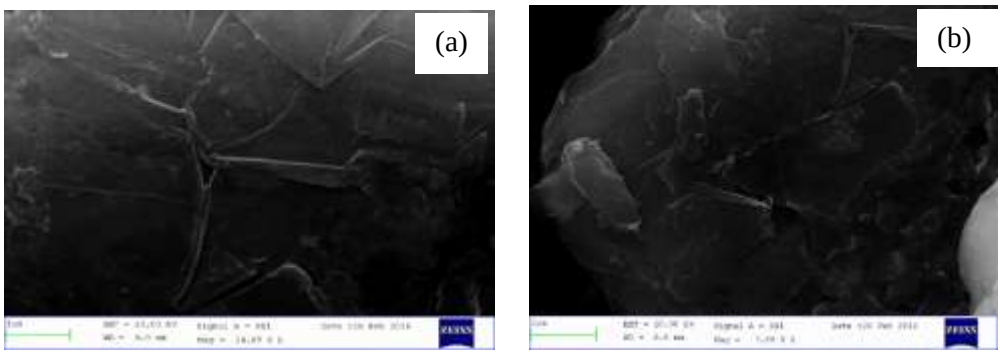


Figure 18 FESEM image of graphene oxide for different scale bars (a) 1 µm, (b) 2 µm

FESEM of SnO_2 Nanofibers

The SnO_2 fibers on ITO glass were carried out to examine by FESEM image. In order to study the morphology and the nano structural properties of fabricated SnO_2 nanofibers for different tip to collector distance (TCD) 5 cm, 7 cm, 10 cm and 12 cm are shown in figure 20 (a) (b), figure 21, figure 22 (a) (b) and figure 23 (a) (b). According to the FESEM analysis SnO_2 nanofibers from all TCD distance reveal the retention of cylindrical shape but with surface roughness. And then, the fibers form TCD 5 cm and TCD 7 cm are straighter and smaller diameter than TCD 10 cm and TCD 12 cm. But most of the fibers of TCD 10 cm TCD 12 cm are uniform but TCD 5 cm and TCD 7cm are not. The average diameter of the SnO_2 nanofibers of TCD 5 cm are 47 - 80 nm, TCD 7 cm are 50-75 nm, TCD 10 cm are 80-85 nm and TCD 12 cm are 100 nm – 102 nm. So, tip to collector distance (TCD) 5 cm is the best position to produce nanofibers because its fibers diameter are the smallest in all position. The fibers diameter for all TCD position are listed in table 4.

Table 4 The fibers diameter for all tip to collector distance (TCD) position

Sample	Fiber diameter (nm)
TCD 5 cm	47
TCD 7 cm	50
TCD 10 cm	80
TCD 12 cm	100

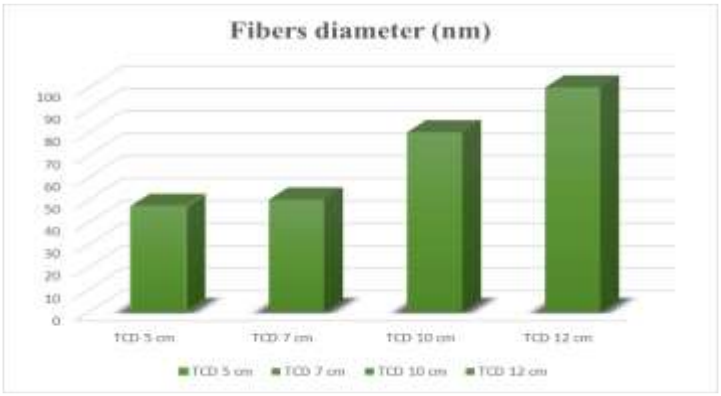


Figure 19 Tip to collector distance (TCD) dependence of fiber diameter

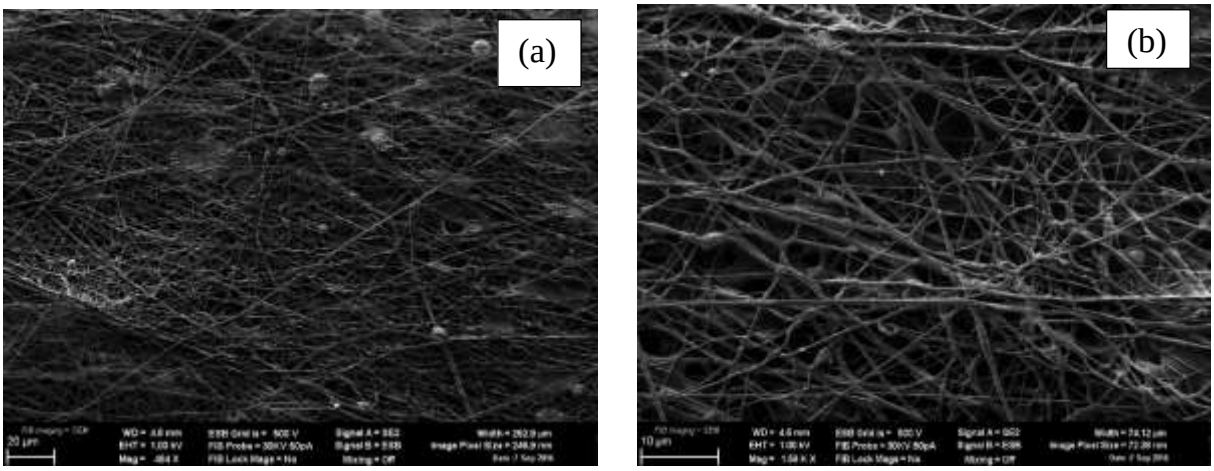


Figure 20 The FESEM image of SnO_2 nanofibers for 5cm (TCD) (a) 20µm (b) 10µm

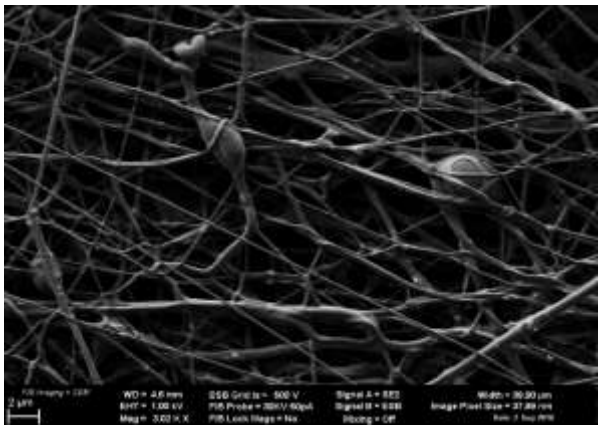


Figure 21 The FESEM photograph of SnO_2 nanofibers for 7cm (TCD)

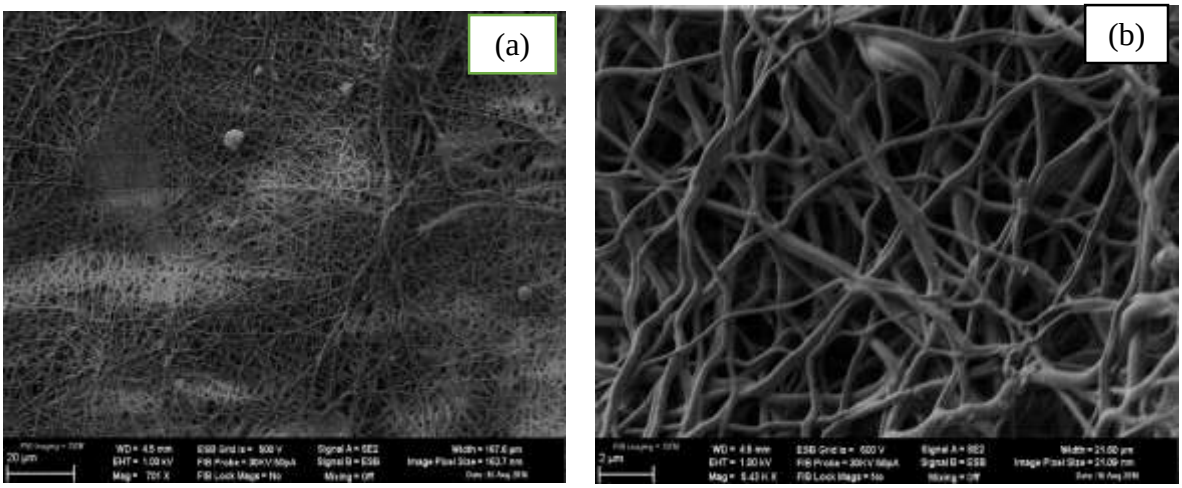


Figure 22 The FESEM images of SnO_2 nanofibers for 10cm (TCD) (a) 20 µm (b) 2 µm

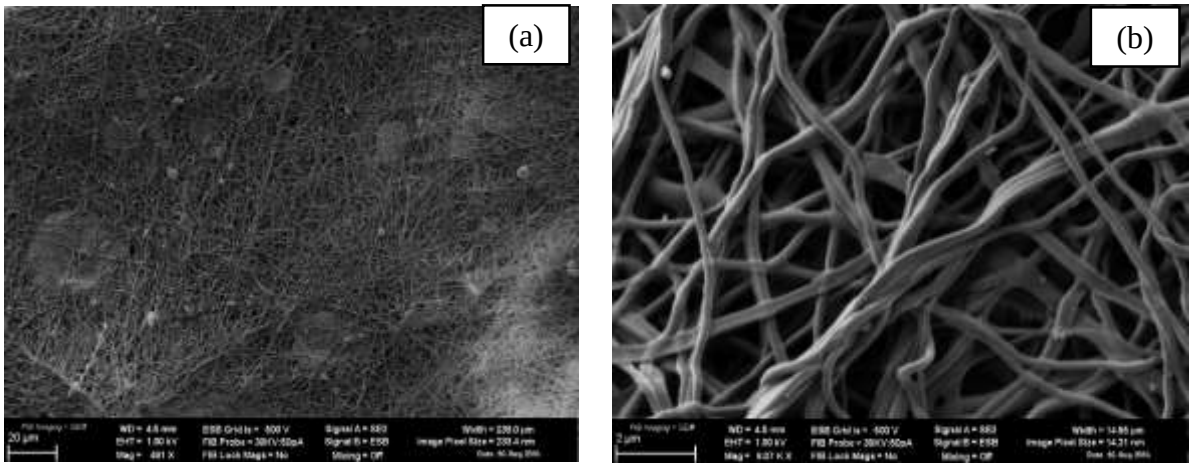


Figure 23 The FESEM images of SnO_2 nanofibers for 12cm (TCD) (a) 20 µm (b) 2 µm

AFM Analysis of SnO_2 Nanofibers

The AFM image of TCD 5 cm and TCD 10 cm are shown in figure 24 and 25. Fiber diameter is estimated from fiber height to avoid tip-convolution effects. According to the line profile, the average fibers diameter for TCD 5 cm are 40 nm – 70 nm and TCD 10 cm are 84 nm –

95 nm. The comparison of fibers diameter between the FESEM and AFM results was listed in table 5. According to the comparison, the result was not very different and the result was acceptable.

Table 5 The comparison of fibers diameter between the FESEM and AFM results

TCD (cm)	Fiber diameter (nm)	
	FESEM	AFM
5	47 - 80	40 - 70
10	80 - 85	84 - 95

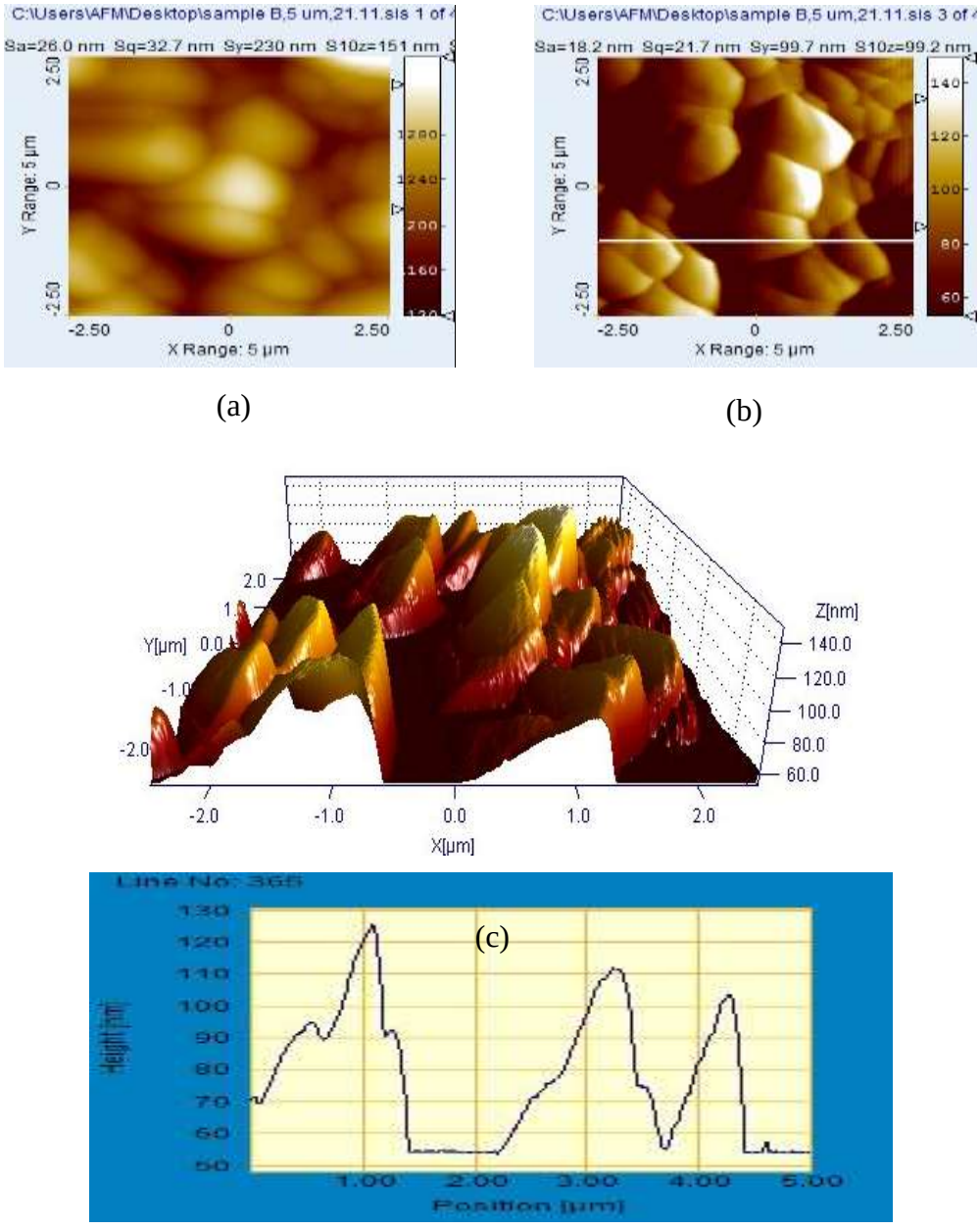
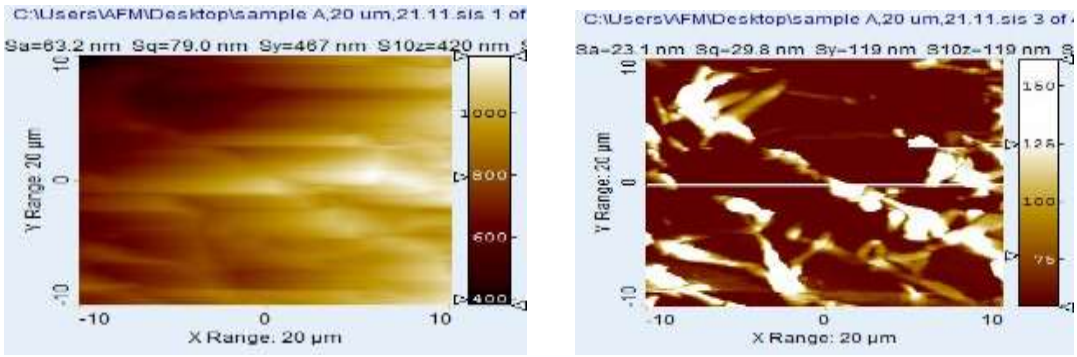
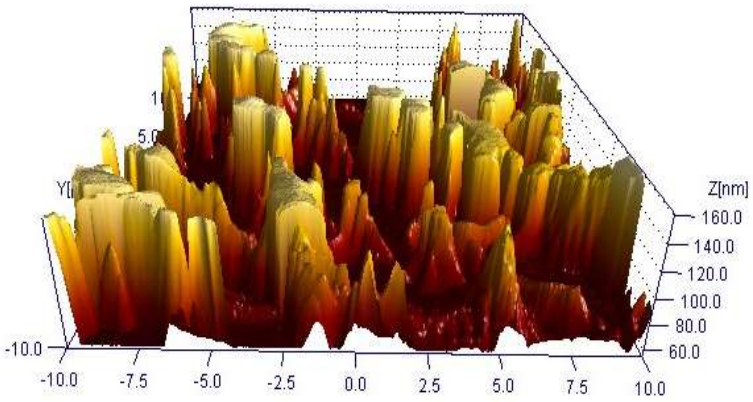


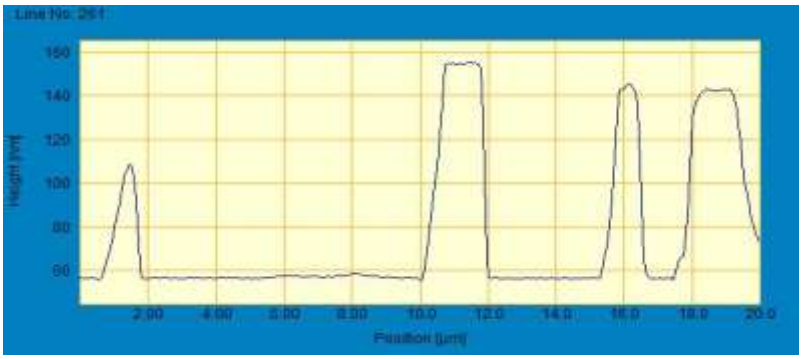
Figure 24 (a) The topography, (b) the amplitude, (c) the 3D image and (d) line profile for TCD 5 cm



(a) (b)



(c)



(d)

Figure 25 (a) The topography, (b) the amplitude, (c) the 3D image and (d) line profile for TCD 10 cm

I-V Characterization under Illumination Condition

The fabricated solar cells were characterized by current-voltage characteristic under illumination. Figure 26 (a), 26 (b) and 26 (c) showed I-V graphs of SnO_2 thin films DSSCs for different annealing temperature. And then, the power voltage graphs of SnO_2 films based DSSCs were shown in figure 27. According to the I-V characteristic, the efficiency and fill factor of 600 ˚C was better than 400 ˚C and 500 ˚C. After that, the nanofiber based DSSCs for different TCD were shown in figure 28 (a), 28 (b), 28 (c) and 28 (d). The P-V graphs were also shown in figure 29 (a), 29 (b), 29 (c) and 29 (d). From I-V graphs, the efficiencies of nanofibers based DSSCs

were better than thin films based DSSCs. Among of them, the efficiency of nanofiber based DSSC (TCD 12 cm) was the best and its efficiency was 2.715 %. The solar cells parameters of SnO_2 nanoparticles-based photo electrodes and SnO_2 nanofibers based DSSCs were listed in table 6 and 7.

Table 6 Photovoltaic parameters of SnO_2 nanoparticles based DSSCs

Sample	Isc(mA)	Jsc(mA/cm^2)	Voc(V)	Efficiency (%)	FF	P_m (mWcm^{-2})
400˚C	2.79E-02	1.40E-02	0.2240	1.147	0.36	3.199E-3
500˚C	2.74E-02	1.37E-02	0.2857	1.645	0.41	2.230E-3
600˚C	3.45E-02	1.72E-02	0.1665	1.778	0.60	3.458E-3

Table 7 Photovoltaic parameters of SnO_2 nanofibers based DSSCs

Sample (TCD)	I_{sc}(mA)	J_{sc}(mA/cm^2)	V_{oc}(V)	Efficiency (%)	FF	P_m (mWcm^{-2})
5cm	3.14E-02	1.57E-02	0.1410	1.902	0.64	5.123E-2
7 cm	3.60E-02	1.80E-02	0.1500	2.235	0.50	6.223E-2
10 cm	3.51E-02	1.76E-02	0.1550	2.260	0.51	6.322E-2
12 cm	4.61E-02	4.60E-02	0.1690	2.715	0.68	1.065E-1

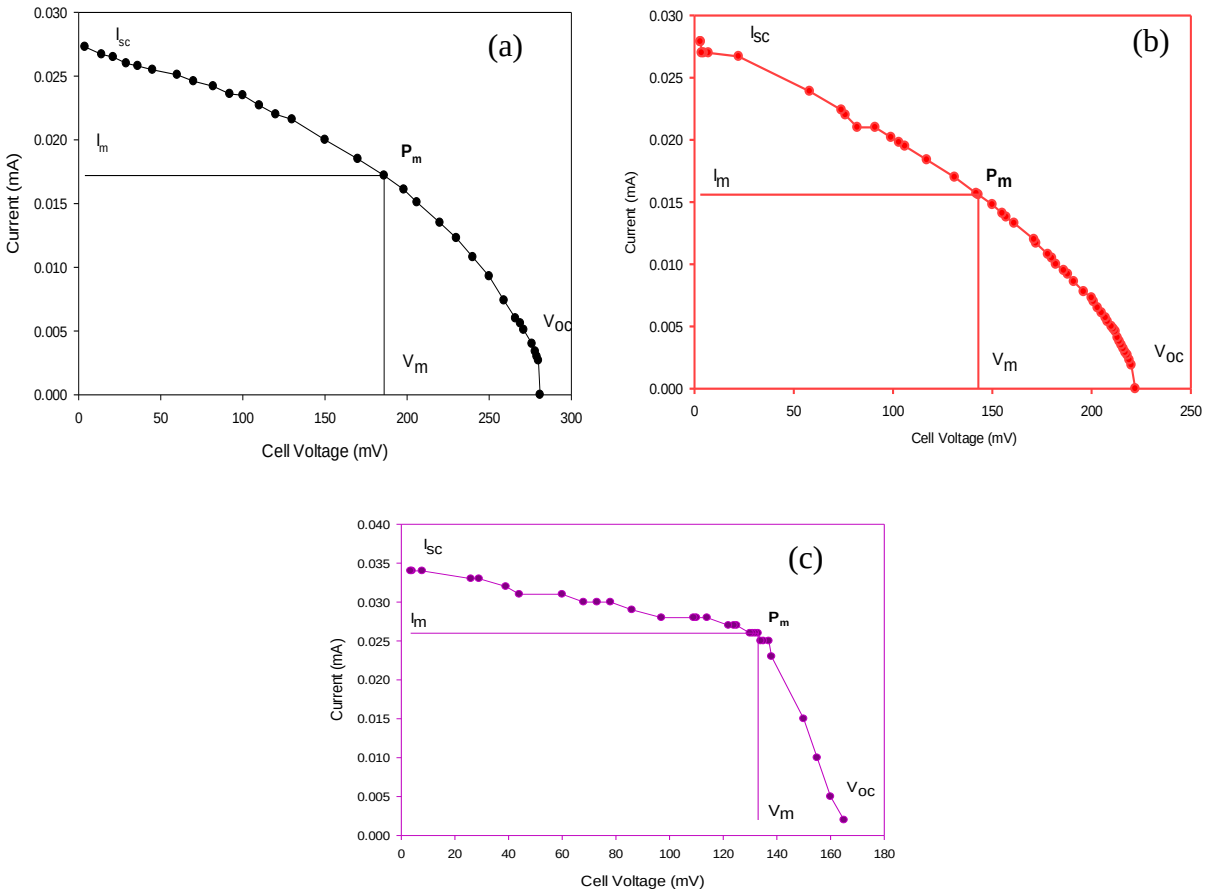


Figure 26 I-V graph of DSSCs for SnO_2 photo electrode at (a) 400˚C (b) 500˚C (c) 600˚C

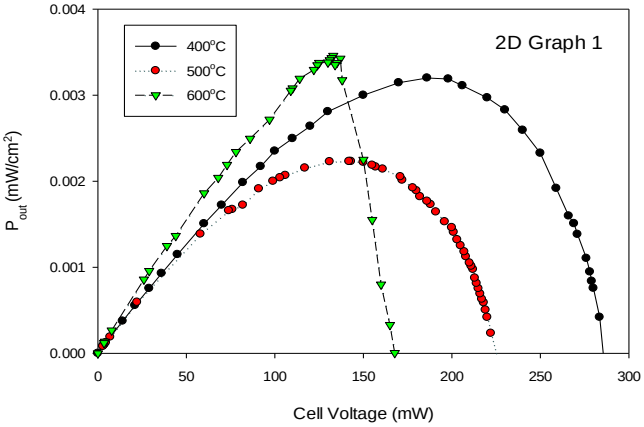


Figure 27 P-V graphs of DSSC solar cells for SnO_2 photo electrode at different annealing temperature.

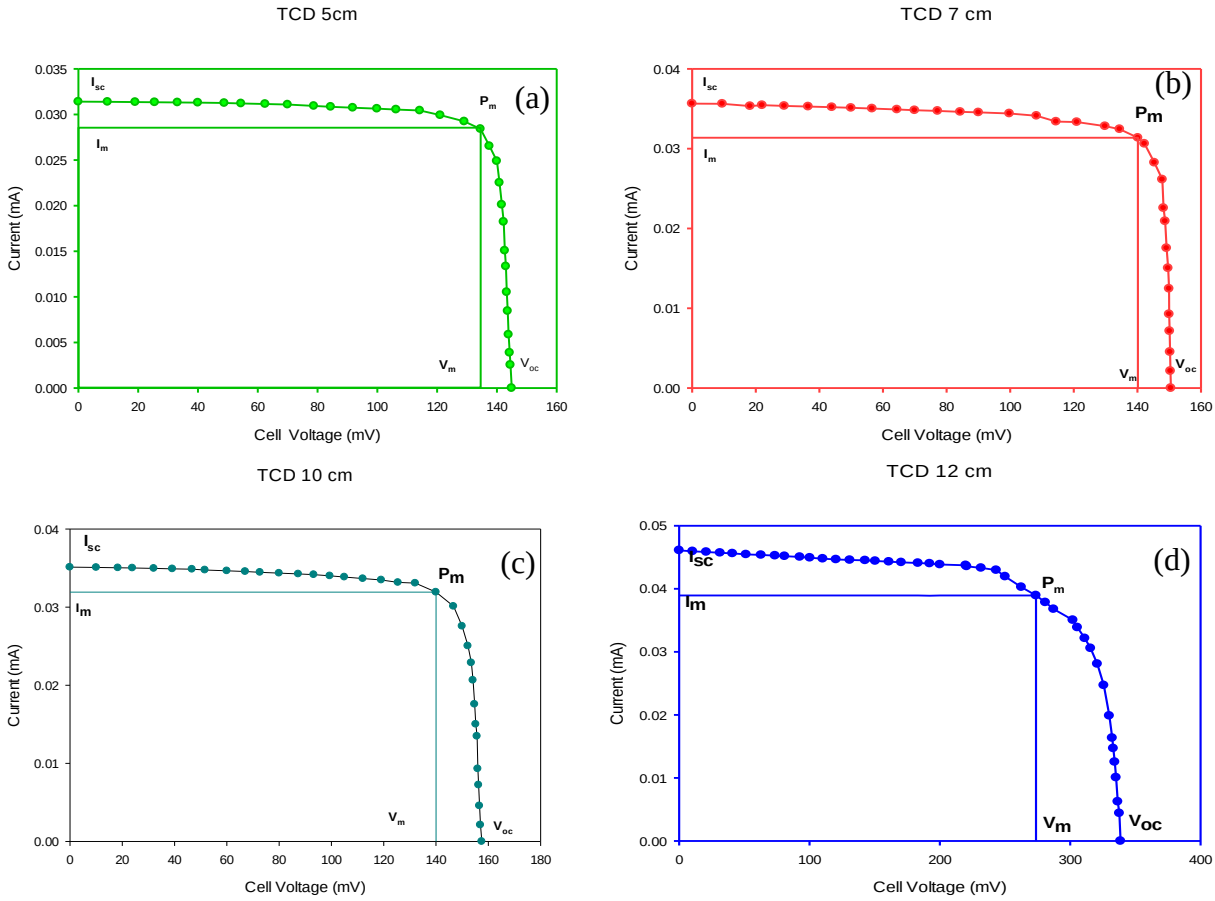


Figure 28 I-V graphs of DSSC solar cells for SnO_2 nanofiber photo electrode at (a) TCD 5 cm (b) TCD 7 cm (c) TCD 10 cm (d) TCD 12 cm

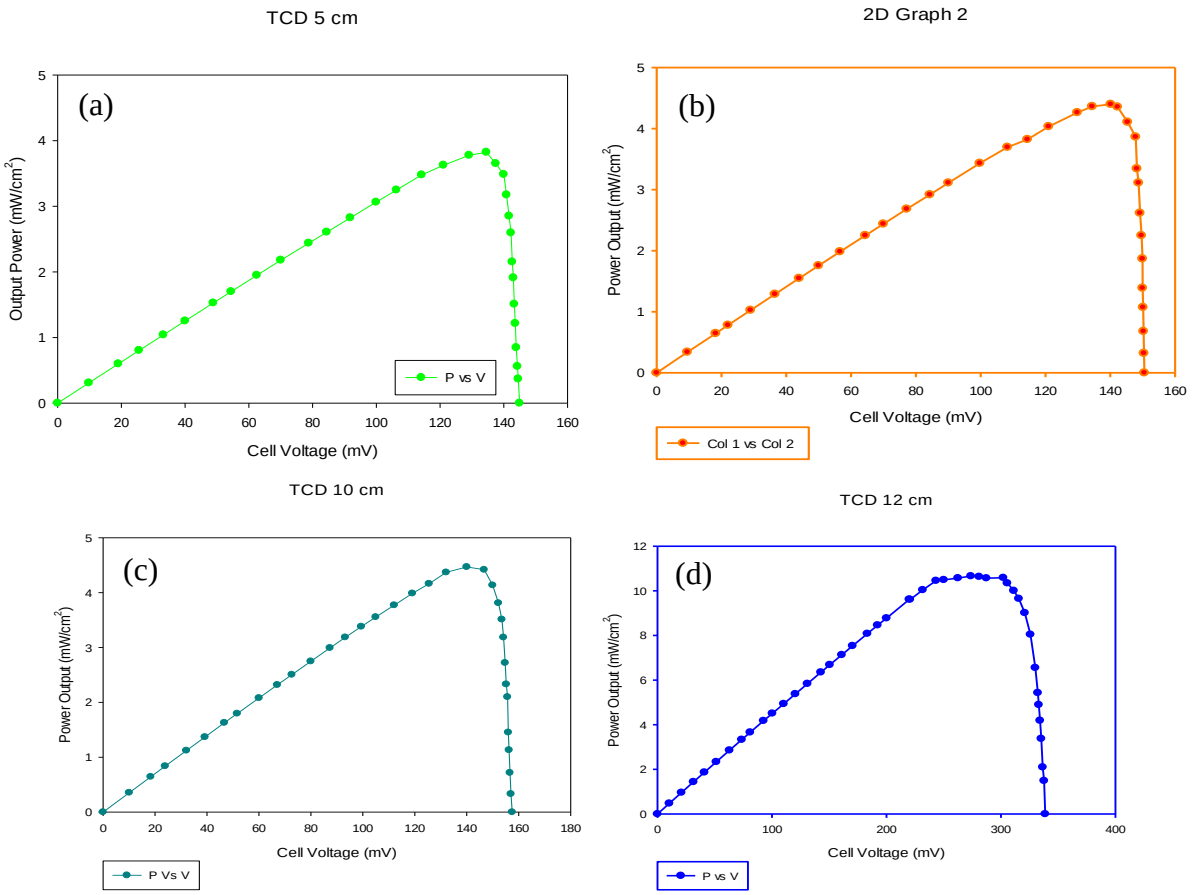


Figure 29 P-V graphs of DSSC solar cells for SnO_2 nanofiber photo electrode at TCD (a) TCD 5 cm (b) TCD 7 cm (c) TCD 10 cm (d) TCD 12 cm

Conclusion

Tin oxide powders were prepared by direct precipitation method from starting material $SnCl_2.2H_2O$. According to the XRD and SEM analyses, the resulting SnO_2 powder indicated the good crystalline nature of the powder. The average crystallite size was 27.49 nm from XRD analysis. The FESEM images indicated the presence of predominantly spherical shape having grain size 80 nm. The optical absorption spectrum showed the sharp absorption edge at 225 nm and 286 nm.

And then SnO_2 nanofibers were fabricated onto Indium doped tin oxide (ITO) glass substrate by home-made electrospinning with vertical experimental set up. Moreover, the tip to collector distance (TCD) was changing in 5 cm, 7 cm, 10 cm and 12 cm. According to the FESEM image the structural properties of fibers deeply depended upon the (TCD) distance. In addition, the SnO_2 nanofibers revealed the retention of cylindrical shape for all TCD distances. Although the fibers from TCD 5cm and 7 cm were straight and small they were nonuniform like the fibers from TCD 10 cm and 12 cm. The average diameter of the SnO_2 nanofibers were 47 - 80 nm, 50 - 75 nm, 80-85 nm and 100 nm – 120 nm for TCD 5 cm, 7 cm, 10 cm and 12 cm respectively. So, the fiber diameter is influenced by the tip to collector distance (TCD).

Moreover, the AFM profiles reveal the fibers diameter of TCD 5 cm are 40 nm – 70 nm and TCD 10 cm are 84 nm – 95 nm. This home-made high voltage power supply and

electrospinning set-up are quite simple, easily made and low cost than the others but it can produce fine nanofibers. SnO_2 thin films have been successfully deposited on ITO glass substrate by spin coating technique and the SnO_2 was well attached onto the ITO/glass. According to the FESEM images, the structural properties were not very different between the films. In this case, the surface structures of the films do not depend upon the changing of calcination temperature.

The graphene oxide (GO) have been successfully synthesized by using Hummer's method. According to the XRD, FTIR and FESEM analysis, the graphite has been oxidized to graphene oxide and it can be used as a counter electrode in DSSCs application. Next, the dry grass was extracted by soxhlet extraction method and according to the UV-Vis analysis the grass dye exhibited the chlorophyll members and applicable for dye sensitizer in DSSCs.

Dye-sensitized solar cells based on SnO_2 nanofiber and nanopowders were successfully prepared and investigated on their structural, microstructural and light absorption properties. Both SnO_2 nanofibers and SnO_2 nanopowders were deposited onto indium doped tin oxide (ITO) glass substrates by electrospinning and spin coating method. The experimental data resulted from this research gave that both SnO_2 nanofibers and nonopowders were successfully favored on ITO/glass even though the fabrication technique used in this study was not confused and complicated. From I-V graphs, the efficiency of nanofibers based DSSCs were better than thin films based DSSCs. Among of them, the efficiency of nanofiber based DSSC (TCD 12 cm) was the best in all DSSCs and its efficiency was 2.715 %. It is expected that both SnO_2 nanofibers based DSSC and SnO_2 thin film based DSSC with grass natural dye are cost effective and Eco friendly DSSC. Moreover, the changing of nanoparticle (0 D) to nanofiber (1 D) is one of the most promising way to enhance the performance of dye sensitized solar cells.

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MODELLING RESIDENTS' SUPPORT FOR TOURISM DEVELOPMENT WITH SPECIAL REFERENCE TO BAGAN-NYAUNG OO AREA, MYANMAR

၂-၈။ MODELLING RESIDENTS' SUPPORT FOR TOURISM DEVELOPMENT WITH SPECIAL REFERENCE TO BAGAN-NYAUNG OO AREA, MYANMAR

Hlaing Hlaing Moe[1]

Abstract

Tourism is a crucial sector of economic growth in many developing countries. Its development can contribute to the achievement of sustainable development goals (SDGs). This study aims to analyze the causal relationship between the residents' attitudes toward community attachment, personal benefits from tourism, the residents' perception of economic, environmental, social, and cultural impacts of tourism, and the residents' support for tourism development using Structural Equation Modelling (SEM). To analyze the influencing factors for residents' support for tourism development, primary data were collected in the Bagan Nyaung Oo Area using a two-stage random sampling method. This study finds that residents' attitudes toward community attachment, personal benefits from tourism, and residents' perceptions of the economic and cultural impacts of tourism are important factors. Residents' perceptions of tourism's economic and cultural impacts are also important mediators in promoting long-term tourism development. The generation of employment and income, contributions to the government revenue and standard of living, the preservation of traditional culture, sustainability of cultural heritage and acculturation are the main economic and cultural impacts of tourism for tourist destinations. Therefore, these impacts should be carried out to implement sustainable tourism development in the Bagan-Nyaung Oo Area. It is also discovered that the positive impacts of tourism outweigh negative ones, and the type of occupation is a moderator variable between residents' perception of tourism impacts (economic and cultural) and support for tourism development in the Bagan-Nyaung Oo Area.

Keywords: Sustainable Tourism Development, Tourism Impacts, Structural Equation Modelling and Residents' Support for Tourism Development

Introduction

Tourism has become a significant industry in both developed and developing countries because it can create income and employment. Nowadays, international tourist arrivals and tourism receipts are rapidly growing around the world. In Southeast Asia, the tourism industry is the most economically developed, with a high level of employment. In Myanmar, tourism is a vital industry that can lead to economic growth. Myanmar's tourism sector is growing rapidly with international tourist arrivals and tourism receipts (MOHT, 2013). Tourism has mainly contributed to Myanmar's development by providing an increase in foreign exchange earnings and employment opportunities and infrastructure development. Myanmar tourism statistics clearly stated that international tourist arrivals increased from 0.66 million in 2005 to 0.79 million in 2010, to 3.08 million in 2014, and to 3.44 million in 2017. The tourism receipts increased from US $254 million in 2010 to US $1789 million in 2014 and to US $1969 million in 2017. The tourism industry accounted for 4.8 per cent of gross domestic product (GDP) and created about 6.5 per cent of job opportunities in 2015.

Myanmar has gained a momentum of success in tourism and significantly strengthened in relation with the international community[2]. It has become an emerging tourist destination for international travellers who are keen to experience Myanmar's abundant wealth of cultural and natural heritage, genuine hospitality, and spiritual values (MOHT, 2013). The most popular tourist sites in Myanmar are Yangon, Mandalay, Bagan, Inle, Pindaya, Ngapali, Ngwe Saung, Kyaikhtiyo,

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[2] Ministry of Hotels and Tourism (MOHT, 2013). Myanmar Tourism Master Plan 2013-2020: Final-Draft Report Myanmar.

and Mrauk Oo. Among these tourist attractions, Bagan, Mrauk Oo, and Pindaya are the historical heritage. The Pyu ancient cities of Myanmar were first inscribed on UNESCO's World Heritage List in June 2014. In July 2019, Bagan was also inscribed on UNESCO's World Heritage List. Bagan is also one of Asia's most archaeological sites.

It seems that the tourism industry has become an essential sector for the economic development of Myanmar. Tourism not only directly contributes to employment and income of residents but it also indirectly contributes to improvement of health, education and infrastructure in the area. The residents should understand and support tourism development because it can give employment opportunities and raise their income and living standards. Regarding the development of tourism, the essential impacts of tourism need to be observed and analyzed. The development of the tourism industry depends on the local residents and community. Sustainable tourism development for communities should be aimed at improving the residents' lives by optimizing local economic benefits and protecting the natural environment. The cooperation of the local residents is essential for the success and sustainability of tourism development. This study aims to develop a model of residents' support for tourism development by means of Structural Equation Modelling (SEM).

Literature Review

There are many researchers and tourism scholars who have carried out studies related to the residents' perceptions and their support for tourism development. According to their studies, the tourism sector can promote the economy of a country, but it can also cause many positive and negative impacts. The nature of tourism's impacts depends on the type of tourism, the tourist sites, and the infrastructure of these tourist sites. Local residents' participation in and support of tourism is important. This study analyzed the previous studies of tourism research, comparing the performance of tourism models developed by using modelling techniques.

Gursoy, Jurowski and Uysal (2002) studied the residents' attitudes in five countries surrounding Virginia (USA) using the structural modelling approach. They proposed a model of host community support for tourism development. The three mediating endogenous variables are the state of the local economy, perceived benefits, and perceived costs. There are four exogenous constructs (community concern, community attachment, ecocentric attitudes, and the utilization of the tourism resource base by residents). Their findings show that the level of concern, ecocentric values, utilization of the resource base, and perceived costs and benefits of tourism development all influence the host community's support for tourism development.

Gursoy and Rutherford (2004) studied host attitudes toward tourism. They proposed that the model and hypothesized paths be tested on the survey data collected from the residents of selected countries in Washington and Idaho by utilizing a two-stage structural equation modeling approach. According to their findings, the host community's backing for tourism development is affected by nine determinants of residents' support, such as the level of community concern, ecocentric values, utilization of tourism resource base, community attachment, the state of the local economy, economic benefits, social benefits, social costs, and cultural benefits.

Kitnuntaviwat and Tang (2008) presented a structural model that explores residents' attitudes towards tourism development and to what extent residents interface with destination sustainability strategies. The 432 respondents were analyzed in Bangkok, Thailand. Confirmatory factor analysis and structural equation modelling are performed on the collected data. The authors

indicated that the residents' support is likely to be strongly affected by most constructs except the relationship between sustainability attitudes and perceived negative tourism impacts.

Untong et al. (2010) analyzed the causal relationship between a destination's tourism potential, the impact of tourism and local resident support for tourism development in four tourist destinations in Thailand (Phuket, Chiang Mai, Pattaya, and Pai). The study found that local residents see private cooperation as an important factor in their support for local tourism development. The economic impact is the main factor influencing local residents' support for tourism development. An increase in investment and business opportunities are important economic impacts for traditional tourist destinations such as Phuket and Pattaya. Local residents in newer tourist destinations (Chiang Mai and Pai) give more importance to local employment opportunities. Regarding the areas of development, local residents in traditional destinations would like to see development in social and cultural attractions, while local residents in newer destinations prefer to see continuous development in physical attractions and amenities.

Marzuki (2011) studied resident attitudes towards the impacts of tourism development in the Langkawi Islands, Malaysia. The study was conducted to explore and identify the impacts of tourism development on the islands and local residents. This study used a household survey based on the stratified random sampling method. An exploratory factor analysis (EFA) was carried out to identify the residents' perceptions of tourism impacts from tourism development. The findings of the study suggested that tourism development in the Langkawi Islands has provided more benefits than costs to the residents.

Lee (2013) concluded research using data from the residents of Cigu wetland, Southwest Taiwan, to assess the support of community residents for sustainable tourism development using the latent variables of community attachment, community involvement, perceived benefits, perceived costs, and support for sustainable tourism development. The author reported that community attachment and community involvement are critical factors that affect the level of support for sustainable tourism development, and the perceived benefits of residents affect the support for sustainable tourism development.

Li and Wan (2013) focused on residents' perceptions and attitudes toward tourism development in Macao. The authors explored the structural relationships between residents' support for tourism development and their perceived positive and negative tourism impacts, job dependency, community attachment, and decision involvement. Path analysis is used for data analysis. The study found that residents' perceptions of tourism impacts are influenced by community attachment and decision involvement, and their support for tourism development can be predicted by their perceptions of tourism impacts and decision involvement.

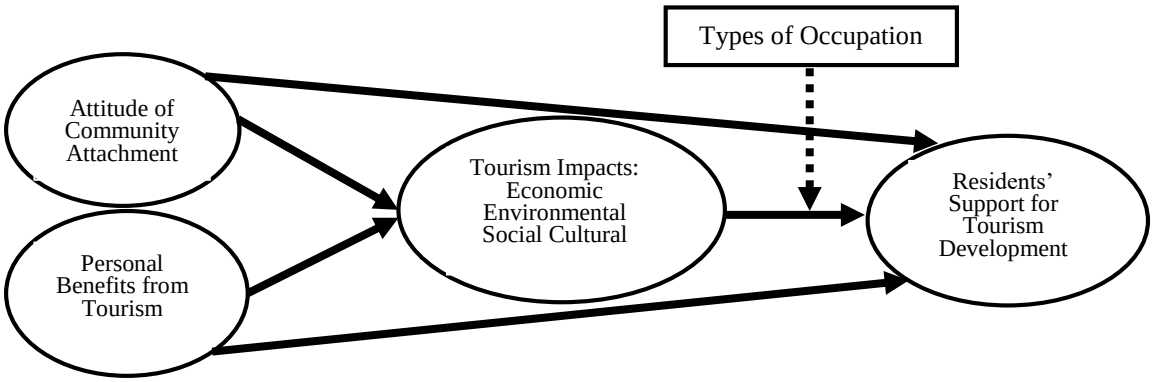
Stylidis et al. (2014) stated the economic, socio-cultural, and environmental impacts of tourism. The residents' perception of these impacts and the role of the residents' place image are measured in shaping their support for tourism development in Kavala, Greece. This study found that residents' place images directly affect their perceptions of tourism impacts and indirectly affect their support for tourism development. Moreover, the authors recommended that more favourable perceptions of the economic, socio-cultural, and environmental impacts lead to greater support of tourism development.

Homsud and Promsaard (2015) proposed a model of residents' support to test the relationship between residents' image, residents' perceived tourism impacts, and residents' satisfaction and support. Then, the effect of the model is examined by using empirical testing. The sample involves 400 people in Hua-hin Prachubkirikhan, Thailand. Structural equation modelling

is used in the study. The authors found that all hypotheses affected the positive results significantly, except for environmental impacts.

Canalejo and Maria (2016) explored that the local residents see tourism as an essential interest in analyzing the economic, socio-cultural, and environmental impacts of tourism development in a certain region. The authors studied the attitudes of residents on the islands of Sal and Boa Vista in the Cape Verde archipelago (Africa). The study showed that the residents are largely in favour of tourism development due to the personal benefits it brings, and they are aware of the negative economic, socio-cultural, and environmental impacts of tourism that do not benefit the community. The authors concluded that the residents have more benefits from tourism development than costs, and they have a large potential for sun and sand tourism development.

As discussed above, various scholars and researchers have presented different perspectives on how tourism impacts and residents' support for development. To analyze tourism impacts and residents' support for development in this study, different measurements of tourism development covering a wide range of perceptions are considered and economic, environmental, social and cultural impacts of tourism development are investigated. Figure 1 presents the conceptual framework of this study.



Source: Own Compilation

Figure 1 Conceptual Framework

Regarding the conceptual framework, the residents' attitudes toward community attachment, personal benefit from tourism, residents' perception of tourism impacts, and support for tourism development are considered below relationships. This study has five structural equations, which were conducted based on a review of the literature.

$$Eco = f(ACA, PBT)$$

$$Env = f(ACA, PBT)$$

$$Soc = f(ACA, PBT)$$

$$Cul = f(ACA, PBT)$$

$$RSTD = f(ACA, PBT, Eco, Env, Soc, Cul)$$

Where, ACA = the residents' attitude of community attachment

PBT = personal benefits from tourism

Eco = the residents' perception of economic impacts of tourism

Env = the residents' perception of environmental impacts of tourism

Soc = the residents' perception of social impacts of tourism

Cul = the residents' perception of cultural impacts of tourism

RSTD= the residents' support for tourism development

Objectives of the Study

The following objectives are set in this study:

(i) To investigate the demographic, socioeconomic and tourism-related characteristics of residents in Bagan-Nyaung Oo Area.

(ii) To analyze the influencing factors of residents' support for tourism development in Bagan-Nyaung Oo Area.

(iii) To examine types of occupation as a moderator variable between residents' perception of tourism impacts and residents' support for tourism development.

Method of Study

Structural Equation Modelling (SEM) was employed for studying the residents' support for tourism development in Bagan-Nyaung Oo Area. Both primary and secondary data were used in this study. The required primary data were collected by using a two-stage sampling with simple random sampling without replacement (SRSWOR) at both stages. A structured questionnaire was used to collect primary data. This study analyzes how the exogenous latent variables are directly related to the endogenous latent variables and it examines directional relationship between endogenous latent variables using SEM. The exogenous latent variables are residents' attitude of community attachment and personal benefits from tourism. The endogenous latent variables are the residents' perception of economic, environmental, social and cultural impacts of tourism and residents' support for tourism development. In addition, Hierarchical Multiple Regression (HMR) was used to examine the interaction effects of occupation types on the relationship between the residents' perception of tourism impacts and residents' support for tourism development.

Survey Design

Sample surveys are the most commonly used method for primary data collection. The household sample survey was conducted in Bagan-Nyaung Oo Area to obtain the required information. To carry out the survey, it is necessary to state clearly the objectives of the survey. The objectives of the survey under the study are:

(i) To collect data on the demographic, socioeconomic, and tourism-related characteristics of residents in the Bagan-Nyaung Oo Area, as well as their attitudes toward community attachment, personal benefits from tourism, and perceptions of tourism impacts.

(ii) To investigate the critical factors influencing tourism development in the Bagan-Nyaung Oo area.

5.1 Questionnaire Design and Data Collection

When the survey objectives have been determined, the relevant questionnaire can be developed. The questionnaire plays a central role in the survey process. The questionnaire used to

collect the required information. The questionnaire basically consists of three main sections. The first section is the demographic, socioeconomic and tourism-related characteristics of household. The second section is the statements of tourism impacts. The third section includes support of residents for tourism development. The questionnaire was prepared for asking the required information from a household head or an adult person in the household. Only one person from each household can be answered the questions.

The target population consisted of permanent residents of Bagan-Nyaung Oo Area who are 18 years and above. Data were collected during December 2017 to February 2018 using a structured questionnaire and personal interview with 446 households. The interviewers provide a brief explanation of the study to answer the questions by the respondents. Therefore, this method has the potential to achieve a higher response rate. Four hundred and thirty-three complete questionnaires were used for data analysis because the incomplete questionnaires have been excluded in the survey.

5.2 Sample Size Determination

In this study, a two-stage sampling design was used to carry out a household sample survey. The sampling design proposed to be employed was two-stage sampling with simple random sampling without replacement (SRSWOR) at both stages. In line with the proposed sampling design, wards were treated as first stage units (FSUs) and households in the FSUs were treated as second stage units (SSUs). In the first-stage sampling, the SRSWOR method has been used to select 50% of wards from the Bagan-Nyaung Oo Area. Therefore, six wards were selected from the sampling frame of the Bagan-Nyaung Oo Area. In the second-stage sampling, households (SSUs) were randomly selected in each selected FSU by the SRSWOR technique.

According to Krejcie and Morgan (1970), the required minimum sample size was calculated using the following formula.

$$n_0 \geq \left(\frac{pq\ z^2}{d^2} \right) = \frac{0.5\ (0.5)\ (1.96)^2}{(0.05)^2} = 384$$

where, p = 0.5 (maximum possible proportion)

d = 5% (acceptable margin of error for proportion)

z = 1.96 for 5% significance level

The households in selected wards were 4980 and the selected households (sample size) were 384. Since sample size exceeds 5% of the population (4980× 0.05=249), Cochran's (1977) correction formula was used to calculate the final sample size.

$$n = \frac{n_0}{1 + \frac{n_0}{population}} = \frac{384}{1 + \frac{384}{4980}} = 357$$

According to the pilot survey, the response rate was assumed to be 80%. The minimum sample size was (357÷0.8=446). Therefore, the required minimum sample size was 446 households. In Table 1, the wards with the total number of households are described. The random numbers 3981, 5467, 6221, 6767, 8466, and 9186 were selected by using generated random numbers. Hence, six wards, such as Ward (4), Ward (5), Ward (7), Kyansittha, Anawrahta, and Thiripyitsaya, were chosen as the first stage units from the Bagan-Nyaung Oo Area. Then,

446 households were selected by using the SRSWOR method at the second stage units. Among 446 sample households, 13 were found to be incomplete. Therefore, 433 sample households were used for the data analysis.

Table 1 List of Households in Bagan-Nyaung Oo Area

Wards	Number of households	Cumulative frequency	Range	P_i	Random number	Number of households in selected wards	Number of selected households
Ward (1)	1679	1679	1-1679	0.174			
Ward (2)	554	2233	1680-2233	0.057			
Ward (3)	1149	3382	2234-3382	0.119			
Ward (4)	834	4216	3383-4216	0.086	3981	834	75
Ward (5)	1412	5628	4217-5628	0.146	5467	1412	127
Ward (6)	587	6215	5629-6215	0.061			
Ward (7)	439	6654	6216-6654	0.045	6221	439	39
Kyansittha	773	7427	6655-7427	0.080	6767	773	69
Anawrahta	1057	8484	7428-8484	0.109	8466	1057	95
Eastyanaung	265	8749	8485-8749	0.027			
Shwetwin	191	8940	8750-8940	0.020			
Thiripyitsaya	465	9405	8941-9405	0.048	9186	465	41
Gangar	272	9677	9406-9677	0.028			
Total	**9677**			**1.00**		**4980**	**446**

Source: General Administration Department of Nyaung Oo Township, 2017

Findings

The purpose of this section is to analyze the influencing factors of residents' support for tourism development in the Bagan-Nyaung Oo Area. This section presents demographic and socioeconomic characteristics of residents and tourism-related characteristics of residents; factor analysis; confirmatory factor analysis; measurement model; structural model; and hierarchical multiple regression.

6.1 Demographic, Socioeconomic and Tourism-Related Characteristics of Residents

The information on demographic, socioeconomic, and tourism-related characteristics of residents is presented in the study.

According to gender, 260 residents (60%) are males, while 173 residents (40%) are females. In terms of the marital status, the majority of the residents (58.4%) are married, followed by singles (28.4%), widows (9.2%), divorce (2.5%) and separate (1.4%). The majority of the residents (92.8%) are Buddhist, followed by Christians (4.8%), Muslims (1.2%) and Hindus (1.2%). According to the birthplace, 55.2% of residents are born in the community, and 44.8% of residents are not born in the community.

Most of the residents (34.4%) are in the age group 31–40 years, followed by the 41-50 age group (26.3%), the 21-30 age group (18.5%), the 51-60 age group (16.9%), the over-60 age group (2.1%) and 18-20 age group (1.8%). The average age of residents is 40 years old. It is found that most of the residents are working-age population in the area.

Regarding household size, 54% of residents have 4 to 6 members, 30.5% of residents have 1 to 3 members, 14.1% of residents have 7 to 9 members, and 1.4% of residents have more than 9 members in each household. Most residents (23.1%) live for 11 to 20 years in the area. The majority of residents (9.7%) are over the age of 50.The average length of residency is 26 years. This means that most residents have been living quite a long time in the area.

The education level of residents is classified as below primary level (4.2%), primary level (14.1%), secondary level (19.4%), tertiary level (15.5%), diploma (13.6%) and bachelor's degree (33.3%). Concerning the monthly income of residents, the majority of residents (31.2%) have earned between 1 and 2 lakh kyats per month, followed by those above 5 lakh kyats (25.8%). The minority of residents (4.2%) have less than 1 lakh kyats.

Relating to the monthly income of the household, the majority of households (55.9%) have earned above 5 lakh kyats, followed by those earning between 4 and 5 lakh kyats per month (13.4%). The minority of households (5.3%) have between 1 and 2 lakh kyats per month. In relation to the monthly expenditure of households, the majority of households (45.7%) spent between1and 2 lakh kyats per month. The minority of households (3.5%) have spent more than 5 lakh kyats.

Regarding tourism-related characteristics of residents, most residents (69.3%) work in the tourism industry, and (30.7%) of residents do not work in the tourism industry. Most residents (38.3%) have a monthly tourism-related income of above 5 lakh kyats. The minority of residents (8.3%) have a monthly tourism-related income of below 1 lakh kyats. Therefore, the residents have a fairly tourism-related income. The majority of residents (79.2%) are not involved in making any tourism-related policies in their area. The minority of residents (20.8%) is involved in making tourism-related policies in their area. Therefore, the residents are working in the tourism industry, but they do not participate in making tourism policies.

Concerning the residents' opinion on tourism development, 50.8% of residents replied that tourism development is in a growth stage and 46.2% of residents replied that tourism development is in a maturity stage. Regarding the residents' opinion on the growth of the Bagan-Nyaung Oo Area, 43.9% of residents replied that their community's growth is moderate, and 49% of residents responded that their community's growth is rapid. According to the residents' opinion on the condition of tourist arrivals, 53.1% of residents responded that the condition of tourist arrivals is moderate, and 20.8% of residents responded that the condition of tourist arrivals is poor. It is discovered that the growth of the Bagan-Nyaung Oo Area is very rapid because the tourism development of this area is the growth stage and condition of tourist arrivals is moderate.

6.2 Factor Analysis

Factor analysis is used for data reduction as well as to screen variables for subsequent analysis. In factor analysis, the variables must be at least ordinal level. Several variables should be included to represent each proposed factor, and the sample size required is at least 100. The assumptions of factor analysis are normality, linearity, and significant correlations in the data matrix.

One of the objectives of this study is to establish a unidimensional scale for the measurement of latent variables. Unidimensionality indicates the existence of a latent variable explaining a set of measured variables. To detect scale dimensionality, an exploratory factor analysis (EFA) with a principal component method is conducted for each latent variable. To determine the appropriateness of factor analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity are examined in the study. KMO value with 0.6 suggests the minimum value for good factor analysis and the statistical significance for

Bartlett's test of sphericity is required. A rule of thumb suggests that factor loadings greater than 0.33 are considered to meet the minimal level of practical significance.

The results of factor analysis are shown in Appendix Table 1. Regarding the results of factor analysis, the residents' attitude to community attachment is measured by five variables. Regarding a principal component factor analysis, all factor loadings are greater than 0.7 and loaded on only one factor. Results of the KMO measure of sampling adequacy 0.880 and Bartlett's test of sphericity (p-value=0.000 < 0.001) indicate that data are acceptable for factor analysis. Cronbach's alpha reliability for five variables is 0.874, and the factor represents 66.7% of the explained variance of the scale. It is concluded that the residents' attitude to community attachment can be measured by five variables, and all of these variables are valid and reliable.

Personal benefits from tourism are measured by five variables. Relating to a principal component factor analysis, all factor loadings are between 0.66 and 0.82. Results of the KMO measure of sampling adequacy 0.834 and Bartlett's test of sphericity (p-value=0.000 < 0.001) indicate that data are acceptable for factor analysis. Cronbach's alpha reliability for five variables is 0.829, and the factor represents 59.6% of the explained variance of the scale. It is discovered that personal benefits from tourism can be measured by five variables, and all these variables are valid and reliable.

The residents' perception of the economic impact of tourism is measured by thirteen variables. According to a principal component factor analysis, factor loadings for eight variables are above 0.7 but those of five variables, such as eco2, eco5, eco6, eco9 and eco13 are less than 0.33. Therefore, these five variables are excluded, and only eight variables are used in the factor analysis. Results of the KMO measure of sampling adequacy 0.889 and Bartlett's test of sphericity (p-value=0.000 < 0.001) indicate that data are acceptable for factor analysis. Cronbach's alpha reliability for eight variables is 0.914, and the factor represents 63.3% of the explained variance of the scale. It is found that the residents' perception of the economic impacts of tourism can be measured by eight variables, and all of these variables are valid and reliable.

The residents' perception of the environmental impacts of tourism is measured by twelve variables. Regarding a principal component factor analysis, factor loadings for seven variables are above 0.7 but those for five variables, such as env1, env2, env3, env6 and env7 are less than 0.33. Therefore, these five variables are excluded, and only seven variables are used in the factor analysis. Results of the KMO measure of sampling adequacy 0.923 and Bartlett's test of sphericity (p-value=0.000 < 0.001) indicate that data are acceptable for factor analysis. Cronbach's alpha reliability for seven variables is 0.912, and the factor represents 65.6% of the explained variance of the scale. Thus, the residents' perception of the environmental impacts of tourism can be measured by seven variables, and all of these variables are valid and reliable.

The residents' perception of the social impacts of tourism is measured by eight variables. Concerning a principal component factor analysis, factor loadings for five variables are above 0.7 but those of three variables, such as soc6, soc7 and soc8 are less than 0.33. Therefore, these three variables are omitted, and only five variables are used in the factor analysis. Results of the KMO measure of sampling adequacy 0.876 and Bartlett's test of sphericity (p-value=0.000 < 0.001) indicate that data are acceptable for factor analysis. Cronbach's alpha reliability for five variables is 0.884, and the factor represents 68.3% of the explained variance of the scale. Therefore, the residents' perception of the social impacts of tourism can be measured by five variables, and all of these variables are valid and reliable.

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6.3 Confirmatory Factor Analysis

Confirmatory factor analysis (CFA) is used to test the measurement model, specifying the posited relations of the measured variables to the underlying latent variables. The CFA approach examines whether or not the collected data is consistent with a prior specified model. Therefore, CFA allows a sample data set that fits the theoretical model, which confirms the validity of the hypothesized model.

For this study, confirmatory factor analysis (CFA) is used to confirm the measurement scale of the residents' attitudes toward community attachment, personal benefits from tourism, the residents' perception of tourism impacts (economic, environmental, social, and cultural) and the residents' support for tourism development. The estimation process for the specified model is provided along with statistical results. Modification indices, absolute fit measures, incremental fit measures, and parsimonious fit measures are utilized to evaluate the specified model. To test the reliability of the latent variables, composite reliability (CR) and average variance extracted (AVE) are used in the study. CR is the reliability of a summated scale, and AVE is the variance in the measured variables explained by the latent variable. At least 0.7 of the composite reliability estimate indicates that a latent variable is moderately reliable in research. To evaluate discriminant validity, AVE is used, and the AVE of all latent variables must be at least 0.5. The results of the confirmatory factor analysis for each latent variable are presented in Appendix Table 2.

Regarding the results of confirmatory factor analysis, five observed variables of the residents' attitude of community attachment, four observed variables of personal benefits from tourism, six observed variables of the residents' perception of economic impacts of tourism, five observed variables of the residents' perception of environmental impacts of tourism, five observed variables of the residents' perception of social impacts of tourism, five observed variables of the residents' perception of cultural impacts of tourism and four observed variables of residents' support for tourism development are retained.

After measuring the adequacy of the individual observed variable, the composite reliability score and variance extracted estimate for each latent variable have been measured. In Appendix Table 2, the composite reliabilities for all measured variables are found to be above 0.80 and the variance extracted estimates for all measured variables are also above 0.50, which indicate acceptable results of fit. It is revealed that 34 measured variables have high reliability and validity.

6.4 Analysis of Proposed Model

Structural equation modeling is a statistical model that seeks to explain the relationships among multiple variables. To estimate the parameters of structural equation models, maximum likelihood method are used in the analysis. The proposed model is analyzed by combining with the two-stage process such as measurement model and structural model.

Measurement Model

The proposed measurement model consists of 7 latent variables and 34 measured variables. The seven latent variables are ACA, PBT, Eco, Env, Soc, Cul and RSTD. Each latent variable has at least four measured variables. These latent and measured variables are presented in Appendix Table 3.

Identification deals with whether enough information exists to identify a solution to a set of structural equations. Information is provided by the sample covariance matrix. In determining the identification of the measurement model, the order condition is assessed. The order condition satisfies that the number of free parameters to be estimated must be less than or equal to the number of distinct values in the matrix $\boldsymbol{S}$. The number of distinct values in the matrix $\boldsymbol{S}$ is $[p(p+1)/2] = [34(34+1)/2]=595$, where p is the number of measured variables in the matrix. The measurement model has 89 free parameters (27 factor loadings, 34 measurement error variances, 7 variances and 21 covariances). The number of free parameters is less than the number of distinct values in the matrix $\boldsymbol{S}$. Therefore, the order condition is satisfied and the proposed measurement model is overidentified.

Regarding the measurement model, the relationships between the measured variables and latent variables are indicated by factor loadings. The factor loadings are provided information about the extent to which a given observed variable is able to measure the latent variable. The unique measurement error is estimated. Before evaluating the proposed measurement model as a whole, it is necessary to evaluate the parameter estimates. First of all, parameter estimates need to determine the significance of parameters. Figure 2 presents the unstandardized parameter estimates for the proposed measurement model. An examination of the unstandardized parameter estimation reveals that all parameter estimates are both reasonable and statistically significant.

Regarding the fit indices of proposed measurement model, the χ^2 value for the model is 757.95 (df=506, p-value=0.000 < 0.01). However, it should be noted that χ^2 model-fit criterion is very sensitive when both sample size and the number of measured variables are large. The χ^2

statistic has a tendency to indicate a significant probability level and frequently results in the rejection of a well-fitting model. Therefore, normed χ^2 is better goodness-of-fit than χ^2. Normed χ^2 is 1.50, which is less than cutting value of 2, indicating the measurement model is an adequate fit. Furthermore, other fit indices are TLI =0.966, CFI=0.969, RMSEA =0.034 and SRMR=0.038. The coefficient of determination is 0.993. The results of goodness-of-fit statistics indicate that the theoretical measurement model is adequately fit to the data.

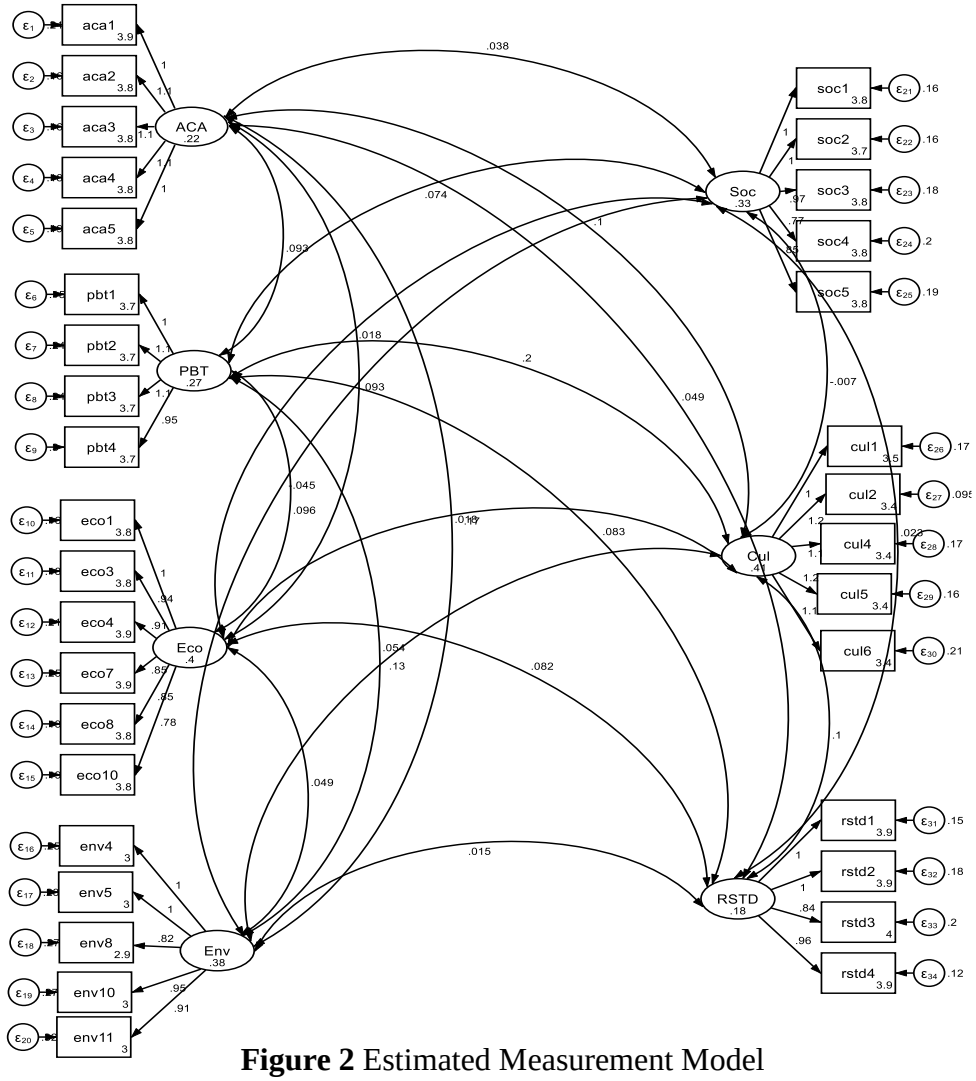

Figure 2 Estimated Measurement Model

Measured variable

Latent variable

Prediction error in latent endogenous variable

Direct relationship between latent exogenous and endogenous variables

Covariance between latent exogenous variables

Structural Model

One of the objectives of this study is to examine the support of residents for tourism development in the community. The proposed structural model deals with the relationships among the seven latent variables. Regarding the structural model, the structural coefficient estimates provide the basis for research analysis. Figure 3 presents the estimated structural model. After identifying the measurement model, the structural model specifies to indicate how these latent variables are related to the study. In determining the identification of the structural model, the order condition is assessed. The order condition satisfies that the number of free parameters to be estimated must be less than or equal to the number of distinct values in the matrix S. The number of distinct values in the matrix S is [p(p+1)/2]= [34(34+1)/2]=595, where p is the number of measured variables in the matrix. The structural model has 83 free parameters (27 factor loadings, 39 measurement error variances, 2 variances, 1 covariance and 14 structural coefficients). The number of free parameters is less than the number of distinct values in the matrix S. Therefore, the order condition is satisfied and the proposed structural model is overidentified.

The structural model includes two latent exogenous variables and five latent endogenous variables. Therefore, the structural model has five structural equations and five prediction errors or disturbances. These five structural equations can be illustrated as follows:

$$Eco = \gamma_1\ ACA + \ \gamma_2\, PBT + \zeta$$

$$Env = \gamma_3\ ACA + \ \gamma_4\, PBT + \zeta$$

$$Soc = \gamma_5\ ACA + \ \gamma_6\, PBT + \zeta$$

$$Cul = \gamma_7\ ACA + \ \gamma_8\, PBT + \zeta$$

$$RSTD = \gamma_9\ ACA + \ \gamma_{10}\, PBT + \ \beta_1\, Eco + \beta_2\, Env + \ \beta_3\, Soc + \beta_4\, Cul + \zeta$$

The structural model is performed for residents' support for tourism development in the study. The unstandardized coefficients of the structural model indicate how much the endogenous latent variable varies with an exogenous latent variable, controlling the other exogenous latent variables. Figure 3 and Table 2 present the unstandardized parameter estimates for the proposed structural model.

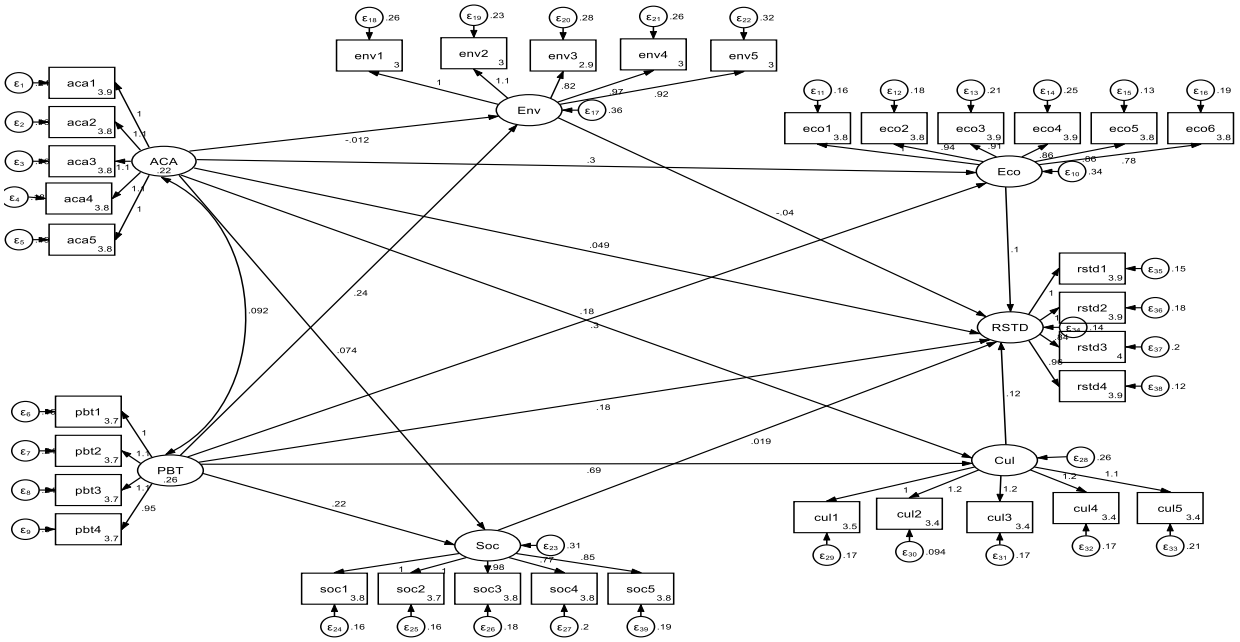

Figure 3 Estimated Structural Model

Measured variable

Latent variable

Prediction error in latent endogenous variable

Direct relationship between latent exogenous and endogenous variables

Covariance between latent exogenous variables

Table 2 Parameter Estimates for Structural Model

Exogenous Variables		Endogenous Variables				
		Eco	**Env**	**Soc**	**Cul**	**RSTD**
ACA	Estimate	0.300	-0.012	0.074	0.176	0.049
	S.E	0.077	0.078	0.071	0.068	0.054
	Z value	3.9***	-0.15	1.04	2.59**	0.90
PBT	Estimate	0.298	0.242	0.219	0.693	0.176
	S.E	0.072	0.075	0.068	0.072	0.066
	Z value	4.12***	3.23***	3.22***	9.63***	2.67***
Eco	Estimate					0.102
	S.E					0.040
	Z value					2.57**
Env	Estimate					-0.040
	S.E					0.039
	Z value					-1.04
Soc	Estimate					0.019
	S.E					0.041
	Z value					0.47
Cul	Estimate					0.121
	S.E					0.048
	Z value					2.52**

***, **, * represent 1%, 5% and 10% level of significance,

Source: Survey Data (2018)

Concerning the results of the structural model, this study shows a significant positive relationship not only between the attitude of community attachment and the perception of positive economic impacts but also between personal benefits from tourism and the perception of positive economic impacts. It is found that residents will perceive positive economic impacts of tourism development if they receive benefits from tourism and attach themselves to their community. A significant positive relationship between personal benefits from tourism and the perception of negative environmental impacts is found in this study. It is discovered that residents receive benefits from tourism, but they also perceive negative environmental impacts from tourism development.

In addition, a significant positive relationship between personal benefits from tourism and the perception of positive social impacts is shown. It is found that residents will perceive positive social impacts of tourism development if they receive benefits from tourism. This study indicates a significant positive relationship not only between the attitude of community attachment and the perception of positive cultural impacts but also between personal benefits from tourism and the perception of positive cultural impacts. It has been discovered that residents will widely perceive the positive cultural impacts of tourism development if they receive benefits from tourism and attach to their community.

It is found that the significant positive relationships are (i) between personal benefits from tourism and residents' support for tourism development, (ii) between the perception of positive economic impacts and residents' support for tourism development; and (iii) between the perception of positive cultural impacts and residents' support for tourism development. It has been discovered that residents will actively support future tourism development if they widely perceive the positive economic and cultural impacts of tourism development and they also receive benefits from tourism.

The structural model shows that the Chi-square value is 833.99 with 512 degree of freedom (p-value=0.000 < 0.01). However, it should be noted that Chi-square statistics become more sensitive when both sample size and the number of measured variables are large. Normed χ^2 (the ratio of χ^2 to degree of freedom) is better goodness-of-fit than χ^2. Therefore, normed χ^2 is 1.63, which is less than cutting value of 2, indicating the structural model is an adequate fit. Furthermore, other fit indices are TLI =0.957, CFI=0.961, RMSEA =0.038 and SRMR=0.064. The coefficient of determination is 0.98. The results of goodness-of-fit statistics indicate that the theoretical structural model is adequately fit to the data.

Analysis of Direct, Indirect and Total Effects

The results of the structural model are analyzed to examine the relationships among the latent variables based on Z-values associated with path coefficients. In this study, a total of fourteen paths and the results of each path are presented in Figure 4 and Table 3.

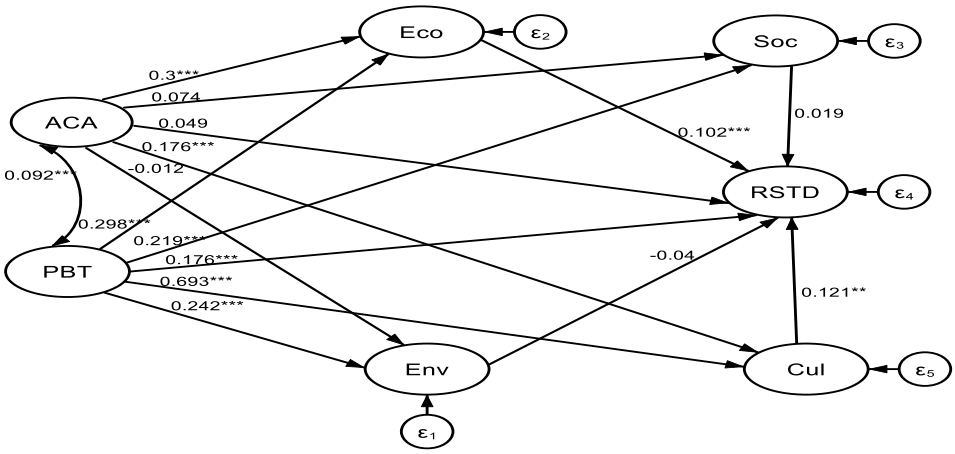

Figure 4 Estimated Structural Model for Latent Variables

***, **, * represent 1%, 5% and 10% level of significance

The result of SEM indicates that there is a significant relationship between the residents' attitudes toward community attachment (ACA) and perceptions of the economic impacts of tourism (Eco). Its relationship has a direct positive effect. The relationship between the residents' attitudes toward community attachment (ACA) and their perceptions of the cultural impacts of tourism (Cul) is significant. Its relationship has a direct positive effect. The result shows that the indirect relationship between the residents' attitude to community attachment (ACA) and the residents' support for tourism development (RSTD) is significant. The residents' attitude to community attachment indirectly influences the residents' support for tourism development through the economic and cultural impacts of tourism as mediator variables. Therefore, the economic and cultural impacts of tourism fully mediate the relationship between the attitude of community attachment and residents' support for tourism development.

The result indicates that the relationship between personal benefits from tourism (PBT) and the residents' perception of the economic impacts of tourism (Eco) is significant and has a direct positive effect. The relationship between personal benefits from tourism and residents' perceptions of environmental impacts of tourism is significant and has a direct positive effect. The relationship between personal benefits from tourism (PBT) and residents' perceptions of social impacts of tourism (Soc) is significant and has a direct positive effect. The relationship between personal benefits from tourism (PBT) and residents' perceptions of the cultural impacts of tourism (Cul) is significant and has a direct positive effect.

These results showed that personal benefits from tourism (PBT) directly and significantly influenced the residents' support for tourism development (RSTD). In addition, personal benefits from tourism (PBT) indirectly and significantly influence residents' support for tourism development (RSTD). Thus, personal benefits from tourism not only directly but also indirectly influence the residents' support for tourism development through economic and cultural impacts of tourism as mediator variables. Therefore, the economic and cultural impacts of tourism partially mediate the relationship between personal benefits from tourism and the residents' support for tourism development.

The result indicates that the residents' perception of the economic impacts of tourism (Eco) positively and directly affects the residents' support for tourism development (RSTD). The result indicates that the residents' perception of the cultural impacts of tourism (Cul) positively and directly affects the residents' support for tourism development (RSTD).

Table 3 Results of Direct, Indirect and Total Effects

Path	Direct Effects		Indirect Effects		Total Effects	
	Coefficient	**Z**	**Coefficient**	**Z**	**Coefficient**	**Z**
ACA→ Eco	0.300***	3.90	-		0.300***	3.90
ACA→ Env	-0.012	-0.15	-		-0.012	-0.15
ACA→ Soc	0.074	1.04	-		0.074	1.04
ACA→ Cul	0.176**	2.59	-		0.176**	2.59
ACA→ RSTD	0.049	0.90	0.054***	2.89	0.103*	1.89
PBT→ Eco	0.298***	4.12	-		0.298***	4.12
PBT → Env	0.242***	3.23	-		0.242***	3.23
PBT → Soc	0.219***	3.22	-		0.219***	3.22
PBT → Cul	0.693***	9.63	-		0.693***	9.63
PBT → RSTD	0.176***	2.67	0.108***	2.92	0.284***	5.27
Eco → RSTD	0.102**	2.57	-		0.102**	2.57
Env → RSTD	-0.040	-1.04	-		-0.040	-1.04
Soc → RSTD	0.019	0.47	-		0.019	0.47
Cul→ RSTD	0.121**	2.52	-		0.121**	2.52

***, **, * represent 1%, 5% and 10% level of significance

Source: Survey Data (2018)

6.5 Analysis of Moderation Effects (Interaction Effects)

Moderation refers to a change in the relationship between an exogenous variable and an endogenous variable, depending on the level of a third variable, termed the moderator variable. This data analysis deals with the interaction effects of occupation types on the relationship between the residents' perception of tourism impacts and the residents' support for tourism development. This study used Hierarchical Multiple Regression (HMR) to examine these interacting (moderating) effects.

The endogenous variable (residents' support for tourism development) is regressed on exogenous variables (residents' perception of economic, environmental, social, and cultural impacts of tourism) and a moderator with the types of occupation designated as a dummy variable. The qualitative variables indicate the presence or absence of an attribute. Hence, "1" may indicate residents who work in the tourism industry, and "0" may designate residents who do not work in the tourism industry in the model. The following procedures were employed to analyze the moderation effects of occupation types on the relationship between the residents' perception of tourism impacts and support for tourism development.

(i) Centre the continuous variables (the residents' perception of economic, environmental, social and cultural impacts of tourism) expected to interact with a categorical variable by creating a new variable.

(ii) Multiply the centred continuous variables by the dummy variable (types of occupation) to create cross-product terms.

(iii) Regress the endogenous variable (residents' support for tourism development) on the exogenous variables of interest using simultaneous equation.

(iv) Add the interaction term. Check the statistical significance of the ΔR^2 to determine whether the interaction is statistically significant.

(v) The moderating effect is verified by observing the statistical significance of ΔR^2. $\Delta R^2 = R_2^2 - R_1^2$, which indicates the proportion of variance in *Y* explained by the interaction effect above and beyond the variance explained by the first-order effects of *X* and *Z*. If ΔR^2 is significant, conduct separate regression for each level of the categorical variable.

The types of occupation variable are designated as a dummy variable. The two groups are explained below.

Group 1: Residents do not work in tourism industry (n=133).

Group 2: Residents work in tourism industry (n=300).

Now consider the following models:

$$Model\ 1:\quad RSTD = \alpha_1 + \alpha_2 D_i + \beta_1 Eco + \beta_2 Env + \beta_3 Soc + \beta_4 Cul + u$$

$$Model\ 2:\quad RSTD = \alpha_1 + \alpha_2 D_i + \beta_1 Eco + \beta_2 Env + \beta_3 Soc + \beta_4 Cul + \beta_5 (EcoD_i) + \beta_6 (EnvD_i) + \beta_7 (SocD_i) + \beta_8 (CulD_i) + u$$

where, RSTD= Residents' support for tourism development

Eco = Residents' perception of economic impacts of tourism

Env = Residents' perception of environmental impacts of tourism

Soc = Residents' perception of social impacts of tourism

Cul = Residents' perception of cultural impacts of tourism

D_i =1 if residents work in tourism industry, and 0 if residents do not work in tourism industry.

The multiple regression models of residents' support for tourism development are shown in Table 4.

Table 4 Results of Hierarchical Multiple Regression Analysis

Variables	Model 1			Model 2		
	Coefficients	**t**	**P value**	**Coefficients**	**t**	**P value**
Constant	3.500***	102.368	0.000	3.569***	92.389	0.000
D_i	0.582***	13.518	0.000	0.516***	11.693	0.000
Eco	0.073**	2.338	0.020	0.112***	2.565	0.009
Env	-0.003	-0.117	0.907	-0.059	-1.086	0.298
Soc	0.059	1.093	0.206	0.054	0.964	0.125
Cul	0.086***	3.308	0.001	0.282***	6.052	0.000
Eco D_i				0.084**	2.625	0.013
Env D_i				0.057	0.935	0.351
Soc D_i				0.071	1.062	0.289
Cul D_i				0.284***	5.108	0.000
F	57.278***			39.578***		0.000
R	0.634			0.705		
R^2	0.401			0.497		
Adjusted R^2	0.394			0.488		
ΔR^2				0.096***	0.000	

Note: ***, **, * represent 1%, 5% and 10% level of significance

Source: Survey Data (2018)

Regarding Model (1), the regression equations of residents' support for tourism development on residents' perception of tourism impacts (economic, environmental, social and

cultural) for both residents do not work in tourism industry (group 1) and work in tourism industry (group 2) are as follows:

$$Group\ 1:\ RSTD = 3.5 + 0.073\,Eco - 0.003Env + 0.059\,Soc + 0.086\,Cul$$

$$Group\ 2:\ RSTD = 4.082 + 0.073\,Eco - 0.003Env + 0.059\,Soc + 0.086\,Cul$$

Regarding Model (2), the regression equations of residents' support for tourism development on residents' perception of tourism impacts (economic, environmental, social and cultural) for both residents do not work in tourism industry (group 1) and work in tourism industry (group 2) are as follows:

$$Group\ 1:\ RSTD = 3.569 + 0.112Eco - 0.059Env + 0.054\,Soc + 0.282\,Cul$$

$$Group\ 2:\ RSTD = 4.085 + 0.196Eco - 0.002Env + 0.125\,Soc + 0.566\,Cul$$

R square change (ΔR^2) shows the increase in variation explained by the addition of the interaction term. In Model 1, R^2=0.401 means that Eco, Env, Soc, Cul and D_i explain about 40.1% of the variation in the residents' support for tourism development. In Model 2, R^2=0.497 means that Eco, Env, Soc, Cul, D_i, $EcoD_i$, $EnvD_i$, $SocD_i$ and $CulD_i$ explain about 49.7% of the variation in the residents' support for tourism development. R square change (ΔR^2 =9.6%) which is the percentage increase in the variation explained by the addition of the interaction term ($EcoD_i$, $EnvD_i$, $SocD_i$ and $CulD_i$). This increase is statistically significant at 1% level (p-value=0.000 < 0.01). It is found that the relationship between residents' perception of tourism impacts (economic and cultural) and support for tourism development is moderated by types of occupation.

Regarding Model 1, the intercepts of residents' support for tourism development are 3.5 for residents do not work in tourism industry and (3.5+0.582=4.082) for residents work in tourism industry, respectively. The coefficient of dummy variable (types of occupation) (α_2=0.582) is statistically significant at 1% level. This means that residents' support for tourism development is expected to be higher by about 0.582 point for residents work in tourism industry than for residents do not work in tourism industry, controlling the residents' perception of tourism impacts (economic, environmental, social and cultural).

Concerning Model 2, the interaction effects of $EcoD_i$ and $CulD_i$ are statistically significant at 5% and 1% level, respectively. A regression equation shows that the intercepts of the residents' support for tourism development are about 3.569 for residents do not work in tourism industry (group 1) and about 4.085 for residents work in tourism industry (group 2). The residents' perception of tourism impacts (economic and cultural) positively relates the residents' support for tourism development for both residents do not work in tourism industry and work in tourism industry. The study is discovered that the relationship between the residents' perception of tourism impacts (economic and cultural) and support for tourism development is stronger for residents work in tourism industry than residents do not work in tourism industry.

Conclusion and Recommendations

Tourism has sustainably developed in Myanmar. Bagan-Nyaung Oo Area is one of the most attractive tourist destinations in Myanmar. Bagan, a rich cultural heritage of Myanmar, is one of the UNESCO World Heritage Sites. In relation to the economy of the Bagan-Nyaung Oo Area, the agricultural sector and the tourism industry are mainly developed. The majority of people are employed in the tourism industry or tourism-related businesses. It has been found that the economy

of the Bagan-Nyaung Oo Area has more rapidly developed than other tourist destinations in Myanmar.

Regarding the demographic and socioeconomic characteristics of residents, 60% of the residents are male. Fifty-five percent of the residents were born in the community, and 69.1 percent work in the tourism industry. Thirty-three point three per cent of the residents achieve a bachelor's degree, and 25.8% of the residents have a tourism-related income above five lakh kyats per month. These results imply that males working in the tourism industry have a median income of 3 lakh kyats per month. Moreover, most of the residents work in the tourism industry, and were born in this area.

Concerning the residents' opinion on the tourism development level of the BaganNyaung Oo Area, tourism development is in a growth stage. Regarding the residents' opinion on the growth of the Bagan-Nyaung Oo Area, this area is experiencing rapid growth. According to the residents' opinion on tourist arrivals, the number of tourist arrivals is moderate. It is found that the development of the Bagan-Nyaung Oo Area is rapid because the tourism development of this area is in its growth stage and tourist arrivals are moderate.

The proposed measurement model is examined to determine whether the theoretical measurement model fits the data well. The unstandardized parameter estimation of the measurement model is statistically significant, and model fit indices are acceptable. Therefore, the proposed measurement model fits the data. The proposed structural model is examined to determine whether the theoretical structural model fits the data well. The structural relationships among latent variables are analyzed in the study. An analysis of the estimated path coefficients in the proposed structural model reveals the significance and direction of each proposed path. Ten of the fourteen proposed paths in the structural model are statistically significant, while four of the paths are not significant. The fit indices of the structural model are acceptable. Therefore, the proposed structural model fits the data.

Concerning the study, the residents' attitude to community attachment directly and significantly affects the residents' perception of tourism impacts (economic and cultural). In addition, residents' attitudes toward community attachment indirectly and significantly affect the residents' support for tourism development through the economic and cultural impacts of tourism as mediator variables. Therefore, the residents' perception of economic and cultural impacts of tourism fully mediates the relationship between the residents' attitude of community attachment and support for tourism development. These findings of the study are in line with previous researches such as Lee (2013), Li and Wan (2013) and Win Min Thant (2017). It is found that local residents attach to their region, and they don't move to other regions. It is exposed that residents perceive more economic and cultural impacts of tourism as well as they attach their community and they would like to support future tourism development.

Personal benefits from tourism directly and significantly affect the residents' perception of tourism impacts (economic, environmental, social and cultural) and the residents' support for tourism development. Then, personal benefits from tourism indirectly and significantly affect residents' support for tourism development through economic and cultural impacts of tourism as mediator variables. Therefore, the residents' perception of the economic and cultural impacts of tourism partially mediates the relationship between personal benefits from tourism and support for tourism development. These findings of the study agree with previous researches by Perdue et al. (1990) and Ko and Stewart (2002). It is found that residents perceive a wide range of positive economic and cultural impacts of tourism, as well as receiving benefits from tourism, and they are likely to support future tourism development.

In addition, the residents' perception of tourism impacts (economic and cultural) directly and significantly affects residents' support for tourism development. These findings of the study agree with previous researches by Lee (2013), Lin and Wan (2013), Stylidis et al. (2014) and Canalejo and Maria (2016). It has been discovered that residents perceive the economic and cultural impacts of tourism positively and that they are likely to support future tourism development.

This study finds that personal benefits from tourism and the residents' perception of the economic and cultural impacts of tourism are the influencing factors of residents' support for tourism development. The significant factors in personal benefits from tourism are (i) personal income is related to tourism, (ii) personal job is related to tourism, (iii) family member's job is related to tourism, and (iv) the individual conservation of local culture is related to tourism. These factors are the essential factors for residents' support for tourism development in the Bagan-Nyaung Oo Area and other tourist attractions.

The important factors in the residents' perception of the economic impacts of tourism are: (i) tourism development has incredibly increased income and employment opportunities for residents; (ii) hotels, guest houses, restaurants, lacquerware firms, and cane firms have gotten more income from tourists because of tourism development; (iii) the local economy depends on tourism; (iv) tourism is important because of getting foreign income; (v) tourism development has raised the living standards of local residents than before; and (vi) local residents can get higher education and improved health care facilities from tourism development. These economic impacts are the main factors in residents' support for tourism development in the Bagan-Nyaung Oo Area and other tourist attractions.

The major factors in the residents' perception of the cultural impacts of tourism are: (i) tourism development has increased residents' pride in the local culture; (ii) tourism development encourages the conservation of cultural activities for local residents; (iii) tourism development maintains the ethnicity of the historical areas and pagodas in the community; (iv) the cultural exchange between tourists and residents is valuable for local residents; and (v) tourists can appreciate and study Myanmar's traditional cultures because of tourism development. These cultural impacts are the main factors for residents' support for tourism development in the Bagan-Nyaung Oo Area and other tourist sites.

This study also analyzes the moderation effect of occupation types on the relationship between the residents' perceptions of tourism impacts and support for tourism development. It has been discovered that the relationship between residents' perceptions of tourism impacts (economic and cultural) and support for tourism development is stronger for residents who work in the tourism industry than for residents who do not work in the tourism industry. So, the residents who work in the tourism industry would actively support tourism development. Hence, the residents' support in the tourism industry is essential to develop sustainable tourism in the Bagan-Nyaung Oo Area and other tourist destinations. The tourism industry of Myanmar is rapidly increasing. The study's major findings include the following recommendations for the government, local governments, tourism planners, and academic scholars.

(i) The proposed tourism model contributes to a theoretical foundation for the relationship among the residents' attitudes toward community attachment, personal benefits from tourism, residents' perceptions of economic, environmental, social, and cultural impacts of tourism development, and residents' support for tourism development. The theoretical model may help in determining future research.

(ii)The residents' attitude of community attachment is the important factor in supporting tourism development. As a result, government and tourism planners should collaborate to create a more beautiful place, a better place for job opportunities, a safer place to live, and a more enjoyable place.

(iii)Personal benefits from tourism are the main factors in residents' support for tourism development. Therefore, the government and tourism planners should implement receiving benefits from tourism in BaganNyaung Oo Area and other tourist sites.

(iv) The residents' perception of the economic impacts of tourism is the key factor in residents' support for tourism development. Therefore, government and tourism planners should implement getting income and job opportunities, receiving foreign earnings, raising the standard of living and developing education and health care facilities in Bagan-Nyaung Oo Area and other tourist sites. In line with these economic impacts of tourism are implemented to increase tourist arrivals and tourism receipts.

(v) The residents' perception of the cultural impacts of tourism is the crucial factor in residents' support for tourism development. Therefore, government and tourism planners should carry out preservation of local culture, conservation of heritage monuments, and acculturation in Bagan-Nyaung Oo Area and other tourist sites. In line with these cultural impacts of tourism are implemented to increase tourist arrivals and tourism receipts.

(vi) Government and tourism planners should implement to increase the positive impacts of tourism, whereas the negative impacts of tourism can be mitigated by practicing sustainable tourism. The government should implement sustainable tourism in Bagan-Nyaung Oo Area and other tourist sites. The residents should obediently act in line with the Tourism Master Plan (2013-2020) and Myanmar Responsible Tourism Policy to support sustainable tourism development. The tourism industry should emphasize responsible tourism, acting on cultural responsibility, social justice, environmental sustainability, and economic viability. Moreover, the cultural heritage monuments in Bagan should be maintained by acting on sustainable and responsible tourism as it is one of UNESCO's World Heritage Sites.

(vii) Bagan has been inscribed on UNESCO's World Heritage List. There may be positive economic and cultural impacts of tourism on the one hand, but on the other hand, negative environmental impacts may be found. Governments and policymakers should manage the fee of entry for tourists not only into the region but also into the heritage monuments like in other ASEAN countries. In addition, the task of showing cultural traditions should be carried out. In addition, environmental pollution, defects in hotel zones, and the loss of agricultural and scenic areas should be reduced to the least by making policy.

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Appendix

Table 1 Results of Factor Analysis for Latent Variables

Latent and measured variables	Factor loadings	Eigenvalue	Variance explained
Attitude of community attachment		3.33	66.7%
aca1, aca2, aca3, aca4, aca5	0.772, 0.845, 0.826, 0.828, 0.810		
KMO measure of sampling	0.880		
adequacy	0.000		
Bartlett's test of sphericity	0.874		
Cronbach's alpha			
Personal benefits from tourism		2.98	59.6%
pbt1, pbt2, pbt3, pbt4, pbt5	0.821, 0.812, 0.789, 0.769, 0.658		
KMO measure of sampling	0.834		
adequacy	0.000		
Bartlett's test of sphericity	0.829		
Cronbach's alpha			
Economic impacts of tourism		5.07	63.3%
eco1, eco3, eco4, eco7, eco8,	0.833, 0.839, 0.797, 0.798, 0.853,		
eco10, eco11, eco12	0.773, 0.721, 0.743		
KMO measure of sampling adequacy	0.889		
Bartlett's test of sphericity	0.000		
Cronbach's alpha	0.914		
Environmental impacts of tourism		4.594	65.6%
env4, env5, env8, env9, env10,	0.833, 0.850, 0.810, 0.729, 0.832		
env11, env12	0.813, 0.798		
KMO measure of sampling	0.923		
adequacy	0.000		
Bartlett's test of sphericity	0.912		
Cronbach's alpha			
Social impacts of tourism		3.413	68.3%
soc1, soc2, soc3, soc4, soc5	0.854, 0.849, 0.843, 0.775, 0.807		
KMO	0.876		
Bartlett's test of sphericity	0.000		
Cronbach's alpha	0.884		
Cultural impacts of tourism		4.469	74.5%
cul1, cul2, cul3, cul4, cul5, cul6	0.823, 0.928, 0.830, 0.902, 0.890,		
KMO measure of sampling	0.797		
adequacy	0.873		
Bartlett's test of sphericity	0.000		
Cronbach's alpha	0.931		
Residents' support for tourism development		2.60	51.9%
rstd1, rstd2, rstd3, rstd4, rstd5	0.792, 0.800, 0.704, 0.815, 0.411		
KMO measure of sampling	0.803		
adequacy	0.000		
Bartlett's test of sphericity	0.756		
Cronbach's alpha			

Source: Survey Data (2018)

Table 2 Results of Confirmatory Factor Analysis for Latent Variables

Latent and measured variables	Standardized loading	CR	AVE	No. of deleted items
Attitude of community attachment		0.88	0.59	0
aca1	0.69			
aca2	0.81			
aca3	0.78			
aca4	0.78			
aca5	0.75			
Personal benefits from tourism		0.83	0.55	1
pbt1	0.80			
pbt2	0.74			
pbt3	0.75			
pbt4	0.67			
Economic impacts of tourism		0.91	0.63	2
eco1	0.85			
eco3	0.81			
eco4	0.78			
eco7	0.73			
eco8	0.83			
eco10	0.75			
Environmental impacts of tourism		0.86	0.56	2
env4	0.77			
env5	0.80			
env8	0.76			
env10	0.69			
env11	0.70			
Social impacts of tourism				
soc1	0.82	0.88	0.6	0
soc2	0.82			
soc3	0.80			
soc4	0.70			
soc5	0.74			
Cultural impacts of tourism		0.94	0.76	1
cul1	0.84			
cul2	0.93			
cul4	0.87			
cul5	0.88			
cul6	0.84			
Residents' support for tourism development		0.82	0.53	1
rstd1	0.74			
rstd2	0.71			
rstd3	0.62			
rstd4	0.75			

Source: Survey Data (2018)

Table 3 Latent and Measured Variables for Measurement Model

Latent and measured variables
Attitude of community attachment (ACA)
aca1: The community is a beautiful place.
aca2: The community is a good place for job opportunity.
aca3: The community has increased residents' standard of living.
aca4: The community is a safe place to live.
aca5: This community is more enjoyable than other communities.
Personal benefits from tourism (PBT)
pbt1: Personal income is related to tourism.
pbt2: Personal job is related to tourism.
pbt3: Family member's job is related to tourism.
pbt4: The individual conservation of local culture is related to tourism.
Economic impacts of tourism (Eco)
eco1: Tourism development has incredibly increased income and employment opportunities of residents.
eco3: Hotels, guest houses, restaurants, lacquerware firms and cane firms have got more income from tourists because of tourism development.
eco4: The local economy depends on tourism.
eco7: Tourism is important because of getting foreign earnings.
eco8: Tourism development has raised living standard of local residents.
eco10: Local residents can get higher education and improved health care facilities from tourism development.
Environmental impacts of tourism (Env)
env4: Tourists have crowded into cultural heritage monuments because of tourism development.
env5: Tourists have crowded into hotels, guest houses and other recreational places because of tourism development.
env8: Transportation for tourists has caused air pollution.
env10: Tourism development has caused littering and noise.
env11: Tourism development has destroyed natural scenery and irrigated lands.
Social impacts of tourism (Soc)
soc1: Tourism development provides the social benefits of local residents in the community.
soc2: Because of tourism development, local services in the community are well maintained.
soc3: Tourism is a major reason for the variety of traditional entertainment in the community.
soc4: Tourism development can provide more parks and other recreational places for local residents.
soc5: Tourism development can provide pagoda festivals in the community.
Cultural impacts of tourism (Cul)
cul1: Tourism development has increased residents' pride in the local culture.
cul2: Tourism development encourages the conservation of cultural activities for local residents.
cul4: Tourism development maintains the ethnic of the historical areas and pagodas in the community.
cul5: The cultural exchange between tourists and residents is valuable for local residents.
cul6: Tourists can appreciate and study Myanmar traditional cultures because of tourism development.
Residents' support for tourism development (RSTD)
rstd1: The residents should financially invest in tourism development.
rstd2: The residents should participate to increase the volume of tourists.
rstd3: The residents should actively participate in sustainable tourism development plans.
rstd4: The residents should promote tourism-related products.

Source: Survey Questionnaire (2018)

AN ANALYTICAL STUDY OF PARENTING KNOWLEDGE AND PRACTICES

AN ANALYTICAL STUDY OF PARENTING KNOWLEDGE AND PRACTICES

Khaing Yee Mon[1]

Abstract

This paper intended to investigate the parenting knowledge levels of parents, to investigate the perceptions of parents on the importance of parenting practices, to investigate the performance levels of parents on parenting practices, to examine the variations of perceptions and performance on parenting practices by the parents' personal factors, and to identify the predictors of parents' personal factors on their parenting practices. Descriptive research design was used in this study. Both quantitative and qualitative methods were used. By using the stratified random sampling method, 420 parents were selected as sample from three strata in Yangon Region. The questionnaire, interview, and observation were used to collect the required data. The internal consistency (Cronbach's alpha) for degree of importance was 0.93 and level of performance was 0.94. Descriptive statistics, Independent Samples *t* Test, One-way ANOVA, Item Percent Correct (IPC), and Multiple Regression Analysis were used to analyze the quantitative data. According to the overall mean value, the findings of the study revealed that parenting knowledge level of parents regarding three areas of knowledge was satisfactory (Mean=0.81, SD=0.14). All the parents perceived that the parenting practices for child physical, emotional, social and cognitive development were important and they often practiced them. Therefore, parents' perceptions on the importance of parenting practices was satisfactory (Mean=3.23, SD=0.31) and level of performance on parenting practices was also satisfactory (Mean=3.10, SD=0.38). There were significant differences in parents' perceptions and performance on parenting practices grouped by level of education, jobs, monthly income, number of family members, number of children, parental education talk, strata and parenting knowledge levels. It was found that the parents' performance levels on parenting practices were more significantly different by the location where they lived. According to the beta weight of multiple regression analysis, strata was the best predictor for parenting practices (R^2=.07, F(6,413)=5.874). According to the result of qualitative study, it was found that the parents from inner and outer suburban strata had no complete basic parenting knowledge and they could not perform the parenting practices satisfactorily.

Keywords: Parenting Knowledge, Parenting practices

Introduction

The quality of family life is fundamental to the physical, psychosocial, and cognitive well-being of children. Many of the skills that children need to acquire are fundamentally dependent on their interactions with their caregivers and the broad social environment. The most important factor to a child's healthy development is to have at least one strong relationship with a caring adult who values and responds to the child's physical, emotional and cognitive needs (Sanders, 1999). Parents are the people who can incorporate all the necessary abilities and competencies of life into their child. The way in which parents bring up their children surely influences their overall development (Durkin, 1995, as cited in George & Rajan, 2012). Parents' tasks are not only to ensure the physical survival of the world, but also to teach good habits, gratify needs, stimulate all facets of development by providing enriching experiences (Brooks, 2004).

Today, attention was focused on the importance of early childhood for the evolution of a person. Most rapid mental growth occurs during infancy and early childhood and thus a child's early years are critical for forming and developing intelligence, personality, and social behaviors (Young, 1997, as cited in Makame, 2001). Parenting during early childhood encompasses

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adaptation to distinctive transformations in human development that affect not only the current well-being of children, but carry significant implications for later life (Brooks, 2004).

Significance of the Study

Startling transformations have occurred all over the world, particularly on the mode of caring and parenting of children. Parents need to be informed and educated in order for all children to benefit in the way of correct care for their health and survival, for a nutrition which is adequate to their physical and psychological development, for the evolution of their intellectual and emotional processes that should lead to the creation of an independent person. When parents fail to fulfill these fundamental responsibilities, there is no doubt that their children often suffer the bad consequences. If the parents want to be effective caregivers for their children, they should possess certain knowledge, skills, attitudes and interpersonal abilities concerning effective parenting. An understanding of parenting practices and child development helps parents understand what to expect and how to provide what children need during each developmental phase (Center for the Study of Social Policy, Georgia, 2012).

More than 200 million children younger than 5 years from developing countries do not achieve their expected level of cognitive development due to poverty, nutritional deficiencies and inadequate early learning opportunities (Bornstein, 2002). More than 32 percent of Myanmar population live below the poverty line. Rural poverty is twice as high as in urban areas and Myanmar also has the second highest child mortality rate (Khalae, 2018). Therefore, most of the children in Myanmar come from low-income families. The parents cannot spend the engaged time with the children and cannot give adequate care or parenting as they are working parents. So, it is clear that large numbers of the children have poor psychosocial development in the first few years of life. When they reach schools, they are unable to benefit fully from education. They usually fail to achieve satisfactory levels and subsequently have poor employment opportunities. This has implications for both the individual and national development.

This research intends to present conclusions and suggestions that should lead to the changing of old mentalities and the development of good parenting practices adequate to the child's development needs. Findings of the research can be used to make a complex analysis of parenting knowledge and practices, to establish the parents' information needs, and offer to decision makers information based on scientific data. The results can also be used for the purpose of developing educational policies and parenting education programs for parents, aimed at developing the potential of children.

Aims of the Study

Main Aim

The main aim is to study the parenting knowledge and practices of parents.

Specific Aims

The specific aims are

- To investigate the parenting knowledge levels of parents
- To investigate the perceptions of parents on the importance of parenting practices
- To investigate the performance levels of parents on parenting practices

- To examine the variations of perceptions and performance on parenting practices by the parents' personal factors
- To identify the predictors of parents' personal factors on their parenting practices

Research Questions

The research questions are:

1. What are the parenting knowledge levels of parents?
2. To what extent do the parents perceive on the importance of parenting practices?
3. What are the performance levels of parents on parenting practices?
4. What are the variations of perceptions and performance on parenting practices by the parents' personal factors?
5. What are the predictors of parents' personal factors on their parenting practices?

Limitation of the Study

This study was geographically limited to Yangon Region. The subjects of this study were 420 parents from 13 Townships in Yangon Region. Parents who have at least one child between 2 and 8 years old participated in this study.

Theoretical Framework

Based on the related literature, the theoretical framework for this study is established.

Parenting knowledge in this study based on three areas of knowledge. They are:

- *Knowledge about child development*

  (for example, knowledge about basic child requirements, abilities, and accomplishments as well as expectations about when a child will achieve a particular development skill)

- *Knowledge about health and safety*

  (for example, basic information about how to promote children's health, how to prevent home accidents, and how to cope effectively with illness)

- *Knowledge about strategies to meet the physical, emotional, social, and cognitive needs of children as they develop* (Bornstein & Ribas, 2005).

Parenting practices in this study cover four areas of child development: physical, emotional, social and cognitive development.

In the area of parenting practices for child physical development, four components of parenting practices are emphasized. They are:

- Supporting Motor Development,
- Providing Opportunities for Physical Activities,
- Providing Good Nutrition, and
- Safeguarding Health (Faegre, 1947, Hildebrend, 1985, & Beaty, 2012)

For child emotional development, nine components of parenting practices are emphasized. They are:

- Promoting Close Emotional Relationship
- Providing Respect and Encouragement
- Providing Opportunities for Outlets
- Handling Mistakes
- Promoting Empathy
- Developing Self-concept
- Developing Self-esteem
- Coaching Children to Manage Emotion and Cope with Stress
- Identifying and Dealing with Negative Feelings (Brooks, 2004)

For child social development, three components of parenting practices will be mainly focused such as

- Promoting Positive Social Relationships with Parents
- Promoting Positive Social Relationships with Siblings, and
- Promoting Positive Social Relationships with Peers (Brooks, 2004)

For child cognitive development, three components of parenting practices are mainly emphasized. They are

- Providing Sensory Experiences
- Providing Opportunities to Think and Imagine
- Providing Games for Sorting, Counting, Classifying and Comparing Objects (Beaty, 2012)

On the basis of this theoretical framework, this study is designed to investigate the parenting knowledge and practices for child physical, emotional, social and cognitive development.

Definitions of Key Terms

Parenting

Parenting is described as a series of actions and interactions on the part of parents to promote the development of children (Brooks, 2004).

Parenting Knowledge

Parenting knowledge is defined as understanding of "development norms and milestones, process of child development, and familiarity with caregiving skills" (Benasich & Brooks-Gunn, 1996).

Parenting Practices

Parenting practices are defined as the specific behaviors that parents use to socialize their children (Anderson, 2011).

Operational Definitions

Parent

A parent in this study is defined as either the biological parent or legal guardian with whom the child lived.

Parenting Knowledge

In this study, parenting knowledge is defined as knowing basic child development principles, basic information about how to promote children's health and to prevent home accidents, and strategies for promoting physical, emotional, social and cognitive development of children.

Parenting Practices

In this study, parenting practices are defined as the behaviors the parents use to promote the physical, emotional, social and cognitive development of their children.

Review of Related Literature

Concept of Parenting

Parenting in general can be described as a series of actions and interactions on the part of parents to promote the development of children (Brooks, 2004). Parenting is the process of promoting and supporting the physical, emotional, social, and intellectual development of a child from infancy to adulthood. Parenting refers to the intricacies of raising a child and not exclusively to the biological relationship (Brooks, 2012).

Parenting Knowledge

Parenting knowledge is defined as understanding of "development norms and milestones, process of child development, and familiarity with caregiving skills" (Benasich & Brooks-Gunn, 1996).

Bornstein and Ribas (2005) also identified three main domains of parenting knowledge: (1) knowledge about child development; (2) knowledge about health and safety; and (3) knowledge about strategies to meet the physical, emotional, social and cognitive needs of children as they develop. Parents use their knowledge to interpret their children's behaviors and development and to guide their own everyday decisions about their children's care and upbringing.

Parenting Practices

Anderson (2011) defined the parenting practices as the specific behaviors that parents use to socialize their children. Evan and Myers (1994) also described that parenting practices include activities which guarantee physical well-being of the child keeping the child safe and free from harm, providing shelter and clothing, recognizing and preventing to illness, and developing motor skills. And activities that promote the psycho-social well-being of the child such as providing emotional security, socialization, nurturing and giving affection are needed to consider as the parenting practices. Parenting practices also include activities such as providing safe places to play and explore, activities that support the mental development of the child such as interaction, stimulation and play, and activities that facilitate the child's interaction with others outside the home.

Parenting Practices and Child Physical Development

Child physical development refers to a child's ability to move, coordinate and control their body (Hildebrand, 1985).

Motor Development

Physical development for young children involves important areas of motor coordination. The term motor development refers to physical growth or growth in the ability of children to use their bodies and physical skills. Motor development often has been defined as the process by which a child acquires movement patterns and skills. This development can be divided into gross motor skills and fine motor skills. Gross motor skill refers to controlling large parts of the body; arms and legs. Fine motor skills refer to coordinating small body parts, hands and fingers (Hildebrand, 1985).

Nutrition, Health and Safety

There are four fundamental factors to be taken into account in estimating the food requirements. These are the requirements for keeping the energy of the body, the needs for growth, the needs for muscular activity, and finally the food values lost in the excreta (Faegre & Anderson, 1947).

Safeguarding their children's health is one of the major interests of intelligent parents, but how best to go about the problem is a matter of careful study. The parents should guard their health by keeping their surrounding clean, by teaching them to wash themselves, by choosing their food sensibly (Faegre & Anderson, 1947). It is important for the parents to recognize the possibility of an infectious disease in any acute illness.

Safety is a parent's first and most important job. The other aspects of parenting —love, limits, values, fun and learning — do not mean a thing without safety. In planning the children's safety, parents have to think safety issues in two settings: outside and inside (Spock & Needlman, 2004). Beaty (2012) stated that the safety of the children includes protecting them from harm or victimization by predatory adults.

Parenting Practices and Child Emotional Development

Emotional development involves learning what feelings and emotions, understanding how and why they happen, recognizing one's own feelings and those of others, and developing effective ways of managing them (Department of Health and Aging, Australia, 2012).

The parents should promote close emotional relationship in two basic ways - by providing sensitive, responsive care that meets the child's needs and by becoming an interactive social partner who shares the child's response to life's experiences (Brooks, 2004). Providing respect and encouragement of parents may assist their children in maximizing positive expressions and minimizing negative expressions (Fabes, Eisenberg, 1991; Tomkins, 1963, as cited in Dehnam et al., 1997). Activities for outlets to drain off tensions and irritation provide children with additional sources of pleasure and feelings of competence (Brooks, 2004).

When children learn a healthy attitude toward mistakes early on, they are freer to explore and act; as a result, they learn and accomplish more. So parents and children can learn to look at mistakes carefully and find out what to do differently the next time (Brooks, 2004). The parents should provide the children books and stories that have moral themes in order to develop empathy towards others. The development of self-concept is the process by which the child gathers information about himself. According to Williamsom (2011), there are three main factors that

affect the development of self-concept in children's lives. They are (1) reaction of others (2) comparison to others, (3) ideal self-image. The parents must help children to develop high self-esteem. Some strategies for developing high self-esteem are: (i) providing a positive atmosphere, (ii) praising, and (iii) setting realistic expectations.

Brooks (2004) also stated that parents can do to express their feelings by coaching children to label their reaction, validating the importance of their feeling whatever they might be and teaching their children strategies for expressing the feelings appropriately. The parents must consider the sources of negative feelings in order to manage them well. Strategies to minimize hassles and negative feelings in the family include (i) creating family time, (ii) developing a support system, (iii) maintaining realistic expectations, and (iv) learning ways to manage negative feelings.

Parenting Practices and Child Social Development

Parents have been said to be the most critical factor in the social development of children (Alvarado & Kumpfer, 2000, Conger & Simons, 1997, as cited in Emmanuel et al., 2012). Social development in children involves interactions with parents, siblings and peers (Brooks, 2004).

Promoting Positive Social Relationships with Parents

Parents meet role expectations and socialize children in three ways: (1) as an interactive partner with the child, (2) as a direct instructor, and (3) as a provider of activities and opportunities that stimulate children's growth.

Promoting Positive Social Relationships with Siblings

When parents are responsive and warm with both children and have secure attachments to each child, the children tend to get along with each other. When parents have a positive relationship with each other, the older siblings develop good emotional control (Brooks, 2004).

Promoting Positive Social Relationships with Peers

Parents should focus on increasing the child's social skills with peers by using three ways: (i) promoting social skills of sharing and taking turns (ii) helping aggressive child, and (iii) helping the shy child.

Parenting Practices and Child Cognitive Development

Parenting quality impacts the early brain development. Piaget also accepted that brain maturation was part of the cognitive development.

Providing Sensory Experiences and Opportunities to Think and Imagine

Cognition develops in children in a sequential manner as they interact with their world and mature in their thinking. During the preoperational stage, children continue to use all five senses to experience the world around them. All the experiences contribute to their mental development. Thought-provoking games, language and exploration are necessary to provide the brain with stimulation for development (Hildebrand, 1985).

According to Beaty (2012), parents should engage children in using their sense to explore new things by asking sensory questions, what things look like, feel like, smell like, taste like and sound like. Open-ended questions are the most valuable. They require children to think and imagine and explore with their senses to come up with an answer.

Providing Games for Sorting, Counting, Classifying and Comparing Objects

Children learn to sort the things they find into categories, compare them with one another, and count them; children develop cognitive concepts that make around the world. If the children can recognize shapes, color and sizes, sort objects on the basis of similar appearance, and discriminate things that are alike from those that are different. These classification skills indicate children's cognitive development (Beaty, 2012).

Methodology

Descriptive research design was used in this study. Both quantitative (questionnaire) and qualitative methods (interview and observation) were used. By using the stratified random sampling method, 420 parents were selected as sample from three strata in Yangon Region. The questionnaire was developed based on the theoretical framework of the study. In order to study the parenting knowledge and practices, the questionnaire was composed of three main parts. Demographic data in part I, 30 true-false items in part II, and 60 four-point Likert-type items in part III were developed. The internal consistency (Cronbach's alpha) for degree of importance was 0.93 and level of performance was 0.94. Descriptive statistics, Independent Samples t Test, One-way ANOVA, Item Percent Correct (IPC), and Multiple Regression Analysis were used to analyze the quantitative data.

Findings

The analysis of collected dada as research findings based on quantitative and qualitative studies will be presented.

Findings on Quantitative Study

Parenting Knowledge

In this quantitative study, the parenting knowledge levels of parents in three areas of child development, child's health and safety and strategies to meet the physical, emotional, social and cognitive needs of children were investigated.

The means and standard deviations of the parenting knowledge levels of parents were presented in Table 1.

Table 1 Means and Standard Deviations of the Parenting Knowledge Levels of Parents (N=420)

Parenting Knowledge Area	Mean	SD	Remark
Child Development	0.82	0.14	Satisfactory Level
Child's Health and Safety	0.86	0.13	Satisfactory Level
Strategies to meet the Physical, Emotional, Social and Cognitive needs of Children	0.76	0.16	Satisfactory Level
Overall	0.81	0.14	Satisfactory Level

According to Table 1, the mean value of overall parenting knowledge was 0.81 and the standard deviation was 0.14. Based on the results, the values above 0.95 (mean+1SD) was defined as above satisfactory level, the values between 0.67 (mean-1SD) and 0.95 (mean+1SD) was defined as satisfactory level and the values below 0.67 (mean-1SD) was defined as below

satisfactory level. According to the table, the parenting knowledge levels of parents were satisfactory levels in all three areas of parenting knowledge.

And then, the number and percentages of parents according to the parenting knowledge levels were described in Table 2.

As indicated in the Table 2, 44 (10.5%) of parents was below satisfactory level, 326 (77.6%) of parents was satisfactory level and 50 (11.9%) of parents was above satisfactory level concerning overall parenting knowledge.

Table 2 Number and Percentages of Parents according to Parenting Knowledge Levels (N=420)

Parenting Knowledge Area	Number and Percentages of Parents		
	Below Satisfactory Level	Satisfactory Level	Above Satisfactory Level
Child Development	62 (14.8%)	270 (64.3%)	88 (21%)
Child's Health and Safety	31 (7.4%)	255 (60.7%)	134 (31.9%)
Strategies to meet the Physical, Emotional, Social and Cognitive Needs of Children	128 (30.5%)	231 (55%)	61 (14.5%)
Overall Parenting Knowledge	44 (10.5%)	326 (77.6%)	50 (11.9%)

The Degree of Importance and Levels of Performance on Parenting Practices for Child Physical, Emotional, Social and Cognitive Development

To study the parents' perceptions on degree of importance and levels of performance on parenting practices, sixty four-point Likert-type items were used. These items were based on four main areas of parenting practices for Child Physical Development, Emotional Development, Social Development and Cognitive Development.

The means and standard deviations of parents' perceptions and performance on parenting practices for child physical development were described in Table 3.

Table 3 Means and Standard Deviations of Perceptions and Performance on Parenting Practices for Child Physical Development (N=420)

No.	Parenting Practices for Child Physical Development	Degree of Importance			Level of Performance		
		Mean	SD	Remark	Mean	SD	Remark
1	Supporting Motor Development	2.94	0.50	Important	2.60	0.67	Often
2	Providing Opportunities for Physical Activities	3.09	0.44	Important	2.76	0.53	Often
3	Providing Good Nutrition	3.50	0.46	Very Important	3.41	0.55	Often
4	Safeguarding Health	3.58	0.41	Very Important	3.61	0.44	Always
5	overall	3.34	0.35	Important	3.19	0.40	Often

Scoring Directions

***Degree of Importance*:** 1.00-1.49=very unimportant 1.50-2.49=unimportant 2.50-3.49= important 3.50-4.00=very important

***Level of Performance*:** 1.00-1.49=never 1.50-2.49=sometimes 2.50-3.49=often 3.50-4.00=always

According to the Table 3, all the parents perceived that the parenting practices for *Child Physical Development* were *important* and they *often practiced* them because the overall mean values were fallen between 2.50 and 3.49.

Table 4 described the means and standard deviations of parents' perceptions and performance on parenting practices for child emotional development.

Table 4 Means and Standard Deviations of Perceptions and Performance of Parents on Parenting Practices for Child Emotional Development (N=420)

No.	Parenting Practices for Child Emotional Development	Degree of Importance			Level of Performance		
		Mean	SD	Remark	Mean	SD	Remark
1	Promoting Close Emotional Relationship	3.35	0.51	Important	3.34	0.61	Often
2	Providing Respect and Encouragement	3.37	0.52	Important	3.24	0.70	Often
3	Providing Opportunities for Outlets	3.19	0.58	Important	2.87	0.87	Often
4	Handling Mistakes	2.99	0.54	Important	3.15	0.60	Often
5	Promoting Empathy	3.32	0.54	Important	3.05	0.78	Often
6	Developing Self-concept	2.52	0.84	Important	2.95	0.92	Often
7	Developing Self-esteem	3.35	0.58	Important	3.32	0.72	Often
8	Coaching Children to Manage Emotion and Cope with Stress	3.14	0.60	Important	3.45	0.60	Often
9	Identifying and Dealing with Negative Feelings	3.26	0.58	Important	3.08	0.77	Often
	Overall	3.20	0.33	Important	3.19	0.41	Often

Scoring Directions

***Degree of Importance*:** 1.00-1.49=very unimportant 1.50-2.49=unimportant 2.50-3.49= important 3.50-4.00=very important

***Level of Performance*:** 1.00-1.49=never 1.50-2.49=sometimes 2.50-3.49=often 3.50-4.00=always

According to the Table 4, all the parents perceived that the parenting practices for *Child Emotional Development* were *important* and they *often practiced* them because the overall mean values were fallen between 2.50 and 3.49

Table 5 described the means and standard deviations of parents' perceptions and performance on parenting practices for child social development.

Table 5 Means and Standard Deviations of Perceptions and Performance of Parents on Parenting Practices for Child Social Development (N=420)

No.	Parenting Practices for Child Social Development	Degree of Importance			Level of Performance		
		Mean	SD	Remark	Mean	SD	Remark
1	Promoting Positive Social Relationships with Parents	3.36	0.45	Important	3.37	0.51	Often
2	Promoting Positive Social Relationships with Siblings	3.34	0.52	Important	3.39	0.59	Often
3	Promoting Positive Social Relationships with Peers	3.18	0.45	Important	3.00	0.57	Often
	Overall	3.27	0.40	Important	3.20	0.48	Often

Scoring Directions

***Degree of Importance*:** 1.00-1.49=very unimportant 1.50-2.49=unimportant 2.50-3.49= important 3.50-4.00=very important

***Level of Performance*:** 1.00-1.49=never 1.50-2.49=sometimes 2.50-3.49=often 3.50-4.00=always.

As indicated in Table 5, all the parents perceived that the parenting practices for *Child Social Development* were *important* and they *often practiced* them because the overall mean values were fallen between 2.50 and 3.49.

Table 6 described the means and standard deviations of parents' perceptions and performance on parenting practices for child cognitive development.

Table 6 Means and Standard Deviations of Perceptions and Performance of Parents on Parenting Practices for Child Cognitive Development (N=420)

No.	Parenting Practices for Child Cognitive Development	Degree of Importance			Level of Performance		
		Mean	SD	Remark	Mean	SD	Remark
1	Providing Sensory Experiences	3.08	0.45	Important	2.77	0.60	Often
2	Providing Opportunities to Think and Imagine	3.10	0.43	Important	2.75	0.60	Often
3	Providing Games for Sorting, Counting, Classifying and Comparing Objects	3.10	0.41	Important	2.86	0.59	Often
	Overall	3.10	0.39	Important	2.80	0.53	Often

Scoring Directions

***Degree of Importance*:** 1.00-1.49=very unimportant 1.50-2.49=unimportant 2.50-3.49= important 3.50-4.00=very important

***Level of Performance*:** 1.00-1.49=never 1.50-2.49=sometimes 2.50-3.49=often 3.50-4.00=always

According to the Table 6, all the parents perceived that the parenting practices for *Child Cognitive Development* were *important* and they *often practiced* them because the overall mean values were fallen between 2.50 and 3.49.

Table 7 described the means and standard deviations of parents' perceptions and performance on parenting practices.

Table 7 Means and Standard Deviations of Perceptions and Performance of Parents on Parenting Practices (N=420)

No.	Parenting Practices Area	Degree of Importance			Level of Performance		
		Mean	SD	Remark	Mean	SD	Remark
1	Child Physical Development	3.34	0.35	Above Satisfactory	3.19	0.40	Satisfactory
2	Child Emotional Development	3.20	0.33	Satisfactory	3.19	0.41	Satisfactory
3	Child Social Development	3.27	0.40	Above Satisfactory	3.20	0.48	Satisfactory
4	Child Cognitive Development	3.10	0.39	Satisfactory	2.80	0.53	Satisfactory
	Overall	3.23	0.31	Satisfactory	3.10	0.38	Satisfactory

Scoring Direction
1.00-1.75= below satisfactory level 1.76-2.50= moderately satisfactory level
2.51-3.25= satisfactory level 3.26-4.00= above satisfactory level

As indicated in Table 7, parents' perception on the importance of parenting practices was satisfactory level and performance level of parents was also satisfactory level because the overall mean values were 3.23 and 3.10 respectively.

Table 8 showed the comparison between the perceptions and performance on parenting practices rated by parents.

Table 8 Comparison between the Perceptions and Performance of Parents on Parenting Practices (N=420)

Parenting Practices Area	No of items	Importance	Performance	*t*	*df*	*p*
		Mean (SD)	Mean (SD)			
Child Physical Development	15	3.34 (0.35)	3.19 (0.40)	8.780	419	.000***
Child Emotional Development	15	3.20 (0.33)	3.19 (0.41)	.200	419	n.s
Child Social Development	15	3.27 (0.40)	3.20 (0.48)	3.330	419	.001**
Child Cognitive Development	15	3.09 (0.39)	2.80 (0.53)	13.230	419	.000***
Overall	60	3.23 (0.31)	3.10 (0.38)	8.590	419	.000***

**p<.01, ***p<.001, n.s= no significance

As shown in Table 8, based on the paired samples *t* test analysis, there was a significant difference between perceptions and performance of parents on parenting practices (t (419)=8.590, p=.000).

Variations of Degree of Importance and Level of Performance on Parenting Practices in terms of Parents' Personal Factors

The means and standard deviations of parents' perceptions and performance on parenting practices with respect to their level of education were shown in Table 9.

Table 9 Means and Standard Deviations of Perceptions and Performance of Parents on Parenting Practices Grouped by Level of Education (N=420)

Parenting Practices Area	Level of Education	N	Degree of Importance		Level of Performance	
			Mean	SD	Mean	SD
Overall (Physical, Emotional, Social and Cognitive Development)	not having formal education	10	3.03	0.30	2.94	0.34
	primary	65	3.18	0.31	3.02	0.44
	secondary	138	3.18	0.34	3.05	0.38
	upper secondary	125	3.20	0.26	3.10	0.33
	diploma/degree	82	3.40	0.28	3.27	0.36

Scoring Directions
***Degree of Importance*:** 1.00-1.49=very unimportant 1.50-2.49=unimportant 2.50-3.49= important 3.50-4.00=very important
***Level of Performance*:** 1.00-1.49=never 1.50-2.49=sometimes 2.50-3.49=often 3.50-4.00=always

According to the Table 9, all five groups of parents perceived that parenting practices for child physical, emotional, social and cognitive development were *important* and all five groups *often practiced* them because the overall mean values were fallen between 2.5 and 3.49.

Table 10 One-Way ANOVA Result of Perceptions and Performance of Parents on Parenting Practices Grouped by Level of Education (N=420)

Parenting Practices Area		Groups	Sum of Squares	*df*	Mean Square	*F*	*p*
Overall (Physical, Emotional, Social and Cognitive Development)	Degree of Importance	Between Groups	3.214	4	.803	8.897	.000***
		Within Groups	37.476	415	.090		
		Total	40.689	419			
	Level of performance	Between Groups	3.441	4	.860	6.300	.000***
		Within Groups	56.668	415	.137		
		Total	60.108	419			

*p<.05, ***p<.001, ns=no significance

As shown in Table 10, there were statistically significant differences in parents' perceptions and performance on parenting practices among five groups of parents because overall degree of importance was (F(4,415)=8.897, p<.001) and overall level of performance was (F(4,415)=6.300, p<.001).

The means and standard deviations of parents' perceptions and performance on parenting practices with respect to their monthly income were shown in Table 11.

Table 11 Means and Standard Deviations of Perceptions and Performance of Parents on Parenting Practices Grouped by Monthly Income (N=420)

Parenting Practices Area	Monthly Income	N	Degree of Importance		Level of Performance	
			Mean	SD	Mean	SD
Overall	Below 200 thousand kyats	128	3.18	0.33	3.00	0.37
	200 thousand to 500 thousand kyats	259	3.23	0.30	3.14	0.37
	Above 500 thousand kyats	33	3.38	0.27	3.19	0.46

Scoring Directions
***Degree of Importance*:** 1.00-1.49=very unimportant 1.50-2.49=unimportant 2.50-3.49= important 3.50-4.00=very important
***Level of Performance*:** 1.00-1.49=never 1.50-2.49=sometimes 2.50-3.49=often 3.50-4.00=always

According to the Table 11, all three groups of parents perceived that parenting practices for child physical, emotional, social and cognitive development were *important* and all three groups *often practiced* them because the overall mean values of level of performance were fallen between 2.5 and 3.49.

Table 12 One-Way ANOVA Result of Perceptions and Performance of Parents on Parenting Practices Grouped by Monthly Income (N=420)

Parenting Practices Area		Groups	Sum of Squares	*df*	Mean Square	*F*	*p*
Overall (Physical, Emotional, Social and Cognitive Development)	Degree of Importance	Between Groups	.975	2	.186	5.116	.006**
		Within Groups	39.715	417	.154		
		Total	40.689	419			
	Level of Performance	Between Groups	2.004	2	1.002	7.193	.001**
		Within Groups	58.104	417	.139		
		Total	60.108	419			

***p*<.05, ***p*<.01, *****p*<.001, **ns=no significance**

According to Table 12, there were statistically significant differences in perceptions and performance on parenting practices among three groups of parents because overall degree of importance was ($F(4,415)=5.116$, $p<.01$) and overall level of performance was ($F(4,415)=7.193$, $p<.01$).

Table 13 described the independent samples *t* test result to show the significant differences in perceptions and performance on parenting practices between the parents group who had below 6 family members and the parents group who had 6 family members and above.

Table 13 Independent Samples *t* Test Result Showing Mean Values of Perceptions and Performance of Parents on Parenting Practices Grouped by the Number of Family Members (N=420)

Parenting Practices Area		No. of Family Members	N	Mean	SD	*t*	*df*	*p*
Overall (Physical, Emotional, Social and Cognitive Development)	Degree of Importance	< 6	305	3.24	0.31	1.584	418	n.s
		≥ 6	115	3.19	0.31			
	Level of Performance	< 6	305	3.13	0.37	3.145	418	.002**
		≥ 6	115	3.01	0.39			

*$p<.05$, **$p<.01$, ns=no significance

As shown in Table 13, regarding the perceptions on parenting practices, there was no significant difference between two groups of parents. But, there was a significant difference in performance between two groups of parents.

Table 14 described the independent samples *t* test result to show the significant differences in perceptions and performance on parenting practices between the parents group who had below 4 children and the parents group who had 4 children and above.

Table 14 Independent Samples *t* Test Result Showing Mean Values of Perceptions and Performance of Parents on Parenting Practices Grouped by the Number of Children (N=420)

Parenting Practices Area		Number of Children	N	Mean	SD	*t*	*df*	*p*
Overall (Physical, Emotional, Social and Cognitive Development)	Degree of Importance	< 4	409	3.23	0.31	3.163	418	.002**
		≥ 4	11	2.94	0.23			
	Level of Performance	< 4	409	3.11	0.37	3.106	418	.002**
		≥ 4	11	2.75	0.45			

*p<.05, **p<.01, ***p<.001, ns=no significance

As shown in Table 14, there was a significant difference between two groups of parents in both perceptions and performance on parenting practices

Table 15 described the means and standard deviations of parents' perceptions and performance on parenting practices according to strata.

Table 15 Means and Standard Deviations of Perceptions and Performance of Parents on Parenting Practices Grouped by Strata (N=420)

Parenting Practices Area	Strata	N	Degree of Importance		Level of Performance	
			Mean	SD	Mean	SD
Overall	downtown	140	3.28	0.27	3.19	0.35
	inner suburban	140	3.18	0.36	3.10	0.42
	outer suburban	140	3.22	0.29	3.01	0.34

Scoring Directions

***Degree of Importance*:** 1.00-1.49=very unimportant 1.50-2.49=unimportant 2.50-3.49= important 3.50-4.00=very important

***Level of Performance*:** 1.00-1.49=never 1.50-2.49=sometimes 2.50-3.49=often 3.50-4.00=always

According to the Table 15, the parents from three strata perceived that parenting practices for child physical, emotional, social and cognitive development were *important* and the parents from three strata *often practiced* them because the overall mean values were fallen between 2.5 and 3.49.

As shown in Table 16, there were statistically significant differences in perceptions and performance on parenting practices among three groups of parents from three strata because overall degree of importance was (F(4,415)=3.296, p<.05) and overall level of performance was (F(4,415)=8.357, p<.001).

Table 16 One-Way ANOVA Result of Perceptions and Performance of Parents on Parenting Practices Grouped by Strata (N=420)

Parenting Practices Area		Groups	Sum of Squares	*df*	Mean Square	*F*	*p*
Overall	Degree of Importance	Between Groups Within Groups Total	.633 40.056 40.689	2 417 419	.317 .096	3.296	.038*
	Level of Performance	Between Groups Within Groups Total	2.316 57.792 60.108	2 417 419	1.158 .139	8.36	.000***

*p<.05, **p<.01, ***p<.001, ns=no significance

Table 17 described the means and standard deviations of the parents' perceptions and performance on parenting practices with respect to their parenting knowledge levels. Based on the levels of parenting knowledge on three areas, the parents were classified into three groups such as Group A (with below satisfactory level), Group B (with satisfactory level) and group C (with above satisfactory level) respectively.

Table 17 Means and Standard Deviations of Perceptions and Performance of Parents on Parenting Practices Grouped by Parenting Knowledge Levels

Parenting Practices Area	Groups	N	Degree of Importance		Level of Performance	
			Mean	SD	Mean	SD
Overall	Group A	44	2.98	0.42	2.98	0.50
	Group B	326	3.24	0.28	3.10	0.36
	Group C	50	3.34	0.27	3.22	0.32

Scoring Directions
Degree of Importance: 1.00-1.49=very unimportant 1.50-2.49=unimportant 2.50-3.49= important 3.50-4.00=very important
Level of Performance: 1.00-1.49=never 1.50-2.49=sometimes 2.50-3.49=often 3.50-4.00=always

According to the Table 17, the parents from groups A, B and C perceived that parenting practices were *important* and all three groups *often practiced* them because the overall mean values were fallen between 2.5 and 3.49.

Table 18 One-Way ANOVA Result of Perceptions and Performance of Parents on Parenting Practices Grouped by Parenting Knowledge Levels (N=420)

Parenting Practices Area		Groups	Sum of Squares	*df*	Mean Square	*F*	*p*
Overall	DI	Between Groups Within Groups Total	3.392 37.298 40.689	2 417 419	1.696 .089	18.96	.000***
	LP	Between Groups Within Groups Total	1.406 58.702 60.108	2 417 419	.703 .141	4.995	.007**

**p<.01, ***p<.001, ns=no significance.

As indicated in Table 18, there were statistically significant differences in perceptions and performance on parenting practices among three groups of parents according to their parenting knowledge levels because overall degree of importance was ($F(4,415)=18.96$, $p<.001$) and overall level of performance was ($F(4,415)=4.995$, $p<.01$).

The Potential Factors Affecting on the Parenting Practices

The means, standard deviations and inter correlations of six variables were shown in Table 19. The combination of variables significantly predicted the parenting practices, F (6,413) = 5.874, $p<.001$.

Table 19 Means, Standard Deviations and Inter-correlation for Parenting Practices and Predictors Variables (N=420)

	Variable	M (SD)	1	2	3	4	5	6
	Parenting Practices	3.03 (.39)	.16***	.15**	.14**	.15**	.15**	.17***
	Predictor Variables							
1	Level of Education	2.49(1.05)		.43***	.04	.12**	.34***	.41***
2	Monthly Income	1.77(.58)			.05	.12**	.19***	.32***
3	Number of family members	1.73(.45)				.27***	.07*	.01
4	Number of Children	1.97(.16)					.03	.06
5	Parenting Knowledge	2.72 (.47)						.14***
6	Strata	2.00(.82)						

$R=.28$, $R^2=.07$, $F(6,413)=5.874$, $*p<.05$, $**p<.01$ $***p<.001$

Table 20 Simultaneous Multiple Regression Analysis for Parents' Personal Factors Predicting Parenting Practices (N=420)

Variables	B	SEB	Beta
Level of Education	.01	.02	.04
Monthly Income	.04	.04	.06
Number of family members	.09	.04	.10*
Number of Children	.24	.12	.10*
Parenting Knowledge	.08	.04	.10
Strata	.06	.03	.12*
Constant	1.97	.25	

$R=.28$, $R^2=.07$, $F(6,413)=5.874$, $*p<.05$

The beta coefficients were described in Table 20. Number of family members, number of children and strata significantly predicted the parenting practices when all six variables were included. The adjusted R squared value was .07. This indicates that 7% of variance in parenting practices was explained.

According to the beta weights, strata variable was the best predictor of parenting practices. And number of family members variable and number of children variable were the second best predictors of parenting practices.

Findings on Qualitative Study

In addition to the quantitative findings, parents' interviews of parenting knowledge and practices were presented as qualitative findings. The parents' interviews were developed with 18 questions based on four areas of parenting knowledge and practices: parenting for Child Physical, Emotional, Social and Cognitive Development. The sampled parents are divided into two groups according to the quantitative results.

Parents' Interview

Most of the parents from Group A know the benefits of playing and they perceived that it is an important vehicle for all-round development of the children. Although all the parents knew the negative effects of using the electronic devices for a long time, they allowed their children to use these devices with a time limit as it could give children a lot of knowledge and information. Concerning the health of the children, they exactly know that inoculation is very important to protect against the childhood diseases and they inoculated their children fully according to the immunization schedule. However, it was surprisingly found that most of the parents had a little knowledge about how to protect their children against the sexual and child abuse. Concerning the emotional development of the children, most of parents perceived that giving and showing affection to the children is the best way for children's emotional development and they always show their affection to their children. They perceived that hitting and scolding can hurt the child's emotion seriously and they know how to handle the mistakes of children in the correct ways. They are knowledgeable about the negative effects of comparing the child with the other child and they never compared their children with the other children. But, most of the parents did not create a family time specially and they did not understand it makes the children emotionally safe and happy. And they often praise their children and they know the benefits of praising. Concerning the social development of the children, most of the parents taught the social behaviors to their children. And they believed that it was necessary for parents to agree with each other in admonishing or disciplining the child. To develop children's positive social skills with siblings, most of the parents treated their children the same, regardless of young and old. However, some parents favored the youngest child among their children. It was also found that the parents allowed their children to participate in group play or activities to develop positive social skills with peers and they know the advantages of cooperative play. Concerning cognitive development of the children, the parents know the benefits of taking the child on field trips and they usually take their children on field trips. It was also found that all the parents know the advantages of telling the stories to the child and they often tell the stories to their children. However, it was also seen that except from only three parents, all other parents did not study parenting education programs specially.

On the other hand, the parents from Group B perceived that playing is necessary for children. But they do not know the benefits of playing. The parents believed that the using the electronic devices for a long time can hurt the child's eyes seriously but they did not know the other negative effects of using these devices. Concerning the health of the children, although the parents know that inoculation is very important to protect against the childhood diseases, some parents did not fully practice this knowledge of importance of inoculation. Some parents inoculated their children only two times because they were busy at the week of inoculation. And, it was also found that most of the parents had a little knowledge about how to protect their children against sexual abuse. Concerning the emotional development of the children, it was surprisingly found that most of the parents misunderstand that giving affection to children makes them become spoilt through and they never show affection to their children. In addition, most of the parents usually use the ways of hitting and scolding for handling the mistakes of children. And, most of the parents

believe that comparing the children with the other children is the best way to make them imitate and emulate the good behaviors of other children. It was also found that all the parents did not create a family time specially and they did not understand it makes the children emotionally safe and happy. And it was also seen that most of the parents misunderstand that praising the child only when he or she is successful is an effective way to promote the child's motivation. Concerning the social development of the children, all the parents do not understand even the concept of social development and they do not teach the social behaviors to their children. However, the parents believed that it is necessary for parents to agree with each other in admonishing or disciplining the child. And, most of the parents favored the youngest child among their children. It was also found that most of the parents did not allow their children to participate in group play or activities as they believe that children can imitate the bad behaviors of other children by participating in group play and activities. Concerning the cognitive development of the children, the parents seldom take their children on field trips as they have no adequate money to go trips. Although the parents know the advantages of telling the stories to the child, they cannot tell the stories to their children as they are illiterate. It was also seen that most of the parents did not study parenting education programs specially. And it was also found that the difficulties of the parents both from Group A and Group B were that they were not fully involved in caring process of their children as they were working parents.

Findings on Observation

In the case of parents from Group A, most of the parents live in apartments and only two parents possess the brick buildings with a small yard. So, most of the parents' houses do not have the adequate places for children to run and play together. And the parents did not provide their children the equipment and materials for physical activities. But, most of the parents provided toys for children to play. Most of the toys are those that support gross-motor development such as ball, bicycle, tricycle, rubber horse that can ride. It was also seen that only one parent provided her children the mini-playground which contains slides and swing. And the children were provided with toys such as sand and clay that can mold, crayon, toys that can insert objects into matching spaces that support fine-motor development of the children. And the toys that support child's imagination and creative thinking skills such as blocks, drawing books, flash cards, jigsaw, musical instruments and toys for role playing such as utensils, materials of a doctor, materials of an engineer, pieces of a chart that can build a town or a house were also provided. And it was also found that most of the parents provided their children stories and picture books that support the child's cognitive development. Concerning the conditions of home environment, although the apartments seem to be clean, they are very close to each other. The streets are narrow and there are some blocked drains. So, it is not good for ventilation. Most of the toilets in parents' houses are clean.

In the case of parents from Group B, some parents possess the wooden houses with a small yard. However, most of the parents live in dense-populated region. They live in terraced houses that are very narrow and small. Therefore, there are no spaces for the children to play together. As they have low socio-economic status, they cannot provide their children the materials or equipment for physical activities. And they cannot provide their children the adequate toys that support gross and fine motor development. Toys such as balls, plastic cars, dolls can be seen in some houses. It was also found that toys that support child's imagination and creative thinking development were not provided. And the children were not provided with stories and picture books. Concerning the environmental conditions, the houses are very small, narrow and dirty. The number of people live does not balance with the area of houses. The streets are also narrow and it is not good for

ventilation as having blocked and polluted drains. As most of the parents use the shared toilets, the toilets are not clean and not safe for children's health.

Conclusion

General Summary

Based on the research questions, the findings of this study could be summarized as follows.

1. Regarding *parenting knowledge*, 44 (10.5%) parents possessed below satisfactory level, 326 (77.6%) parents possessed satisfactory level and 50 (11.9%) of parents possessed above satisfactory level.
2. Regarding the *parents' perceptions*, the parents perceived that the parenting practices for child physical, emotional, social and cognitive development were *important.* It was also found that the parents' perceptions on the importance of parenting practices for *Child Physical Development* and *Child Social Development* were *above satisfactory levels* and another two areas such as parenting practices for *Child Emotional Development* and *Child Cognitive Development* were *satisfactory levels*.
3. Regarding the *parents' performance*, the parents *often practiced* on the parenting practices for child physical, emotional, social and cognitive development. It was also found that the parents' performance levels on parenting practices were *satisfactory levels* in all four areas.
4. There were significant differences in parents' perceptions and performance on parenting practices grouped by level of education, jobs, monthly income, the number of family members, the number of children, parental education talk, strata and parenting knowledge levels.
5. The parents' parenting practices were significantly predicted by number of family members, number of children and strata when all six variables were included. According to the beta weights, strata variable was the most striking or potential predictor of parenting practices.

Discussion

Parenting knowledge and practices are vital to the overall well-being of the children, parents and society. Based on the results of quantitative and qualitative findings, the discussion of the research study is presented.

Because the parents are the main caregivers of young children, the extent and quality of their parenting knowledge is often considered vital to improving children's all-round development and parenting knowledge may inform parenting practices (Donahue et al., 1997, as cited in Bornstein et al., 2012). The quantitative findings of this study revealed that parenting knowledge levels of parents were satisfactory in all three areas: knowledge about child development, child's health and safety, and strategies to meet the physical, emotional, social and cognitive development of children. Specifically, among three areas, the knowledge level on the area of child's health and safety was the highest. But, according to the results of interview, the parents from group B did not fully inoculate their children according to the immunization schedule. They failed to inoculate their children with a reason of busying at the week of inoculation. This finding pointed out that the parents did not know inoculation as an essential thing for children's health. And, the results of interview described that almost all the parents had a little knowledge concerning how to protect

their children against sexual abuse. Therefore, it can be concluded that the parents under this study had a fair but less than complete basic parenting knowledge.

According to the quantitative study, all the parents' perceptions and performance levels on parenting practices were satisfactory. Specifically, among four areas, parenting practices for child physical development was above satisfactory level and the highest category. However, the qualitative findings of this study did not follow the conceptualization of Hildebrand (1985) that supporting motor development is an important aspect for physical development of young children. Although most of the parents from group A provided their children the toys that support motor development, all the parents from group B could not provide their children adequate toys that support motor development. Majority of children were experiencing the rural poverty, where most of the families had scarce resources that were not even enough for the basic needs. In such families, buying toys is no priority. The parents did not surely know the benefits of playing. And observation results described that almost all children were not provided with the adequate places to play together because parents lived in apartments and terraced houses. It can be concluded that the parents were still weak in implementing them in the real situations.

The strongest potentially factor contributing to the development of behavioral and emotional development of children is the quality of parenting a child receives (Sanders & Morawska, 2014). The quantitative findings of this study revealed that all the parents perceived that all components of parenting practices for child emotional development were important and they often practiced them. However, the results of interview described that group B parents neither knew nor practiced the parenting practices for promoting emotional development of children. They did not show love, affection and respect to their children as they believed that children became spoilt through when they were loved. They misunderstood that the children would pay attention to their instruction only when they were afraid to them. These findings did not follow the conceptualization of Utting (2007) that warm, authoritative, and responsive parenting practices are usually crucial in developing the emotion of the children. Therefore, it can be interpreted that parents did not aware that showing affection to the child was an important factor for emotional development of the child.

In the findings of the study of Proulx (2014), most of children were exposed to physical punishment which typically involved adults 'whipping' their children to correct their behaviors and teach them. Most children were disciplined using a combination of violent and non-violent means. The result of the current study was congruent with the study of Proulx, (2014). Most of the parents used the ways of hitting and scolding to handle the mistakes of their children. They believed that these ways were very effective to get the children to listen, to correct their bad behaviors and not to violate the disciplines again. This finding pointed out that parents did not take into account the fact that physical punishment would negatively affect the emotional development of children.

According to Utting (2007), the quality of parent-child relationship appears to remain influential into adulthood for social and behavioral outcomes. The quantitative findings of this study revealed that all the parents perceived that three components of parenting practices for child social development were important and they often practiced them. Although this study described promoting positive social relationship with siblings as an important component, the result of interview pointed out that most of the parents under the study favored the youngest child and they believed that parents should favor the younger child more in any way. According to the findings of current study, the parents did not emphasize the importance of positive social relationship among siblings described by Bryant (1980, as cited in Bornstein, 2002) that parents' treating siblings differently has also been linked to negative relationship among the siblings.

In this study, most of the parents from group B did not understand the importance of cooperative play and they even had the negative attitudes on cooperative play. They believed that children could imitate the bad behaviors of others and they were likely to be rude when they were allowed to participate in group play or activities. This finding opposed the notion of Suryana (2017) that through cooperative play, children show a better ability in activities of cooperation, healthier psychological development, being able to accept the differences that exit between friends of the group.

In addition, among the three components of parenting practices for child cognitive development, providing sensory experiences was the lowest component in perceptions and providing opportunities to think and imagine was the lowest component in performance. The quantitative findings were congruent with the results of qualitative findings. Although parents from group A often took their children on field trips, parents from group B seldom took their children field trips to provide sensory experiences. They could not provide their children such activities because of low socio-economic status. The results of interview and observation pointed out that the parents from group B could not provide their children adequate stories and pictures books that support the child's thinking and imagination. Besides, parents had no ability to read and write as they were illiterate. They could not tell the stories to their children and they did not understand the benefits of storytelling. All these findings described that the parents were unaware of the importance of the concept of Hildebrand (1985) that children continue to use all five senses to experience the world around them during the pre-operational stage and thought provoking games, language and exploration are necessary to provide the brain with stimulation for development.

Both the quantitative and qualitative findings of the current study revealed that the parents' performance levels on parenting practices were lower than their perceptions. The main reason of why they could not perform as they perceived was that most of the parents did not thoroughly know which parenting practices were useful and effective for children. Also as expected, there were significant differences in parenting practices and perceptions by the parents' educational level, socio-economic status and the location where they lived. In the quantitative study, the more educated groups who had diploma or degree had the highest perceptions and performance and the parents group who had no formal education had the lowest perceptions and performance on parenting practices. And the parents group who got high monthly income had the highest perceptions and performance and the parents group who got low monthly income had the lowest perceptions and performance on parenting practices. These findings were identical the findings of Gross (1993, as cited in Bornstein et al., 2012) that parents higher in socio-economic status and those with more education may possess more knowledge of parenting and more practice them at hand. Poverty causes some parents to be more stressed, depressed or irritable, and this in turn disrupts their parenting practices and styles and produce poorer long-term outcomes for children (Utting, 2007). This may be one possible explanation for these findings in this study.

Moreover, the findings of the current study were congruent the findings of Williams (2000, as cited in Bornstein & Ribas, 2005) that urban fathers and mothers with more education had higher developmental expectations and could implement earlier the specific parenting practices than the rural mothers and fathers. In this study, the parents from downtown had the highest perceptions and performance on parenting practices and the parents from inner and outer suburban had the lowest perceptions and performance on parenting practices. It could be that the parents from downtown had higher socio-economic status and higher educational level than the parents from inner suburban and outer suburban areas. In addition, residential area was the most potential predictor on parenting practices in this study.

In the study of Sanders and Morawska (2014), when mothers have higher knowledge of child development, they show higher levels of parenting skills and practices. The current study validated the findings of Sanders and Morawska (2014) that there were significant differences in perceptions and performance of parenting practices among the parents groups with regard to their levels of parenting knowledge. It was also discovered that the parents group who had the highest levels of parenting knowledge can perform the parenting practices at hand more than any other groups. Thus, imparting parenting knowledge to parents may be the first priority service needed to be given by the professionals.

This study highlighted the parenting knowledge and practices of parents that were being used in the current society and the most influential factors on parenting practices. Based on the interpretations of this study, it can be concluded that parenting knowledge of parents were not enough to have a complete basic parenting knowledge and they could not fully implement the parenting practices at hand. The data and outcomes in this study pointed out that there is a pressing need to make a cooperation among parents, public authorities, policy makers, professionals in education and health sector, and media partners for implementing appropriate evidence-based interventions, effective early childhood education programs, and parenting education programs aimed at enhancing the parenting knowledge, skills, practices of parents and their life competencies.

Recommendations

Public authorities should

- inform and educate the community to be able to realize and aware the role of parents as an essential element for community development.
- organize evening classes, holiday programs of parenting education for working parents especially in rural and migrant areas in order to increase their parenting abilities.
- create a better correlation and mutual collaboration between Ministries and Departments involved in child health and education, and child protection.

Professionals in Education Sector should

- elaborate the training programs for parents know their role as the first educator for developing the intellectual and cognitive development of their children.
- develop a mini and simple child development guide manual that will describe clearly child development requirements and milestones that can be easily used and interpreted by parents and community facilitator.
- do research, projects, and workshops that will facilitate the development of strategies and practices for effective parenting.

Professionals in Health Sector should

- educate the importance of inoculation and encourage the parents to inoculate their children fully according to the immunization schedule.
- educate and inform the parents all hygiene aspects such as food hygiene practices, self-hygiene and environmental hygiene practices.
- create parents' information centers and health care centers to provide services for children's health.

Media Partners should

- use mass media, especially of radios, television channels, and social media effectively as the mediators to educate the parents about parenting.
- use pictures and cartoons effectively to communicate messages as the effectiveness of print is limited where illiteracy is high.

Parents should

- study the effective parenting strategies and practices for promoting child physical, emotional, social and cognitive development of children.
- participate actively in meetings, parenting talk, workshops, and debates developed by professionals in community.
- get information from information resource centers and advice places whenever they have difficulties in their parenting.

Need for Further Research

Future research should include investigating the parenting knowledge and practices of parents in other townships, states and regions in order to represent the whole country.

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LEGAL STUDY ON THE INTERPRETATION AND IMPLEMENTATION OF TRIPS AGREEMENT

LEGAL STUDY ON THE INTERPRETATION AND IMPLEMENTATION OF TRIPS AGREEMENT

Phyu Phyu Thinn[1]

Abstract

Protection of Intellectual Property Rights (IPRs) is accepted as the key component on the free flow of goods and trade liberalization in the global economy. It is the Agreement Trade Related Aspects of Intellectual Property Rights which was established as a multilateral trade agreement and provides the minimum standards for the protection of IP at the national level. The protection of IP is designed to create incentives on their works for creators as a private right, it may lead to generate concerns in the implementation of TRIPS Agreement by the countries particularly the developing ones. While the developed countries express concerns for more extensive and effective IP protection system to their R&D innovative industry, the developing countries face problems due to the impacts of IP rules particularly the access to medicine of the poor. This may cause certain problems in implementation processes. The TRIPS Agreement should be interpreted and implemented in the way balancing to the promotion and distribution of technology, to the mutual benefits between creators (mostly from developed countries) and users (from developing countries) in a manner tends to bring social and economic welfare.

Introduction

Technology increases efficiency in industrial productivity, which is necessary for economic growth and development. There was a link between trade issues and Intellectual Property (IP) that it was made explicit by the requirement that all WTO members have to be a party and accept all World Trade Organization (WTO) multi-lateral agreements as Agreement on the Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) and cannot escape from their treaty obligations. The TRIPS Agreement contains minimum standards for the protection of IP relating to copyright and related rights, trademarks, geographical indications, industrial designs, patents, layout-designs of integrated circuits, and undisclosed information. There are framework provisions concerning the effective enforcement for Intellectual Property Rights (IPRs) and in particular, procedures for the provisional measures not only to prevent the infringement of IPRs but also to deter further infringement of those rights.

It is so obvious that IPRs has focused on the private rights. In addition, the dissemination of knowledge has been at the heart of the IP System for encouraging future innovation using current innovations and ideas. There is an idea which expressly confirmed in Article 7 of the TRIPS Agreement to recognize the requirement to balancing the IP rights between creators and users. There are certain provisions and inducements for developing countries to comply in their implementation of IPRs protection within their domestic system. At the same time, it recognizes the desire of developed countries to enjoy their innovations and to enter international trade activity with extended IP protection on their inventions and ideas. The TRIPS Agreement lies in the heart of these concepts of benefit balancing with its flexibilities.

As a part of fulfillment of such international commitment for establishment of strong IP system, Myanmar has promulgated Trademark Law as well as Industrial Design Rights Law in January, 2019, Patent Law in March and also Copyright Law in May, 2019 respectively. Currently, Myanmar is in the position of preparing necessary arrangements to establish effective legal

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protection system of IPRs in Myanmar. The TRIPS Agreement would be the foundation and framework for the protection and enforcement of IPRs in Myanmar by using the TRIPS-flexibilities both in interpreting and in implementing these new IP laws.

2. Aims and Objectives of the Research

This research aims

- to recognize the role of TRIPS Agreement in the field of intellectual property and to clarify its linkage between trade and IPRs for economic growth and development to WTO members.
- to study the rules of interpretation of the provisions of TRIPS Agreement whether protection and enforcement of IPRs would actually contribute to the innovation and to the mutual benefits between creators and users as outlined in its aims and objectives.
- to identify the common issues that all countries might face in the implementation of TRIPS Agreement and to find out possible solutions to overcome these obstacles.
- to provide contributions to national legislation for the establishment of effective and efficient protection system of IPRs in Myanmar consistent with the TRIPS Agreement.

3. Concept of Intellectual Property Rights (IPRs)

Intellectual property simply refers to the "creation of mind". But it plays an increasingly vital role in global trade and economic development. Intellectual property has moved into the mainstream of national economic and developmental planning though it has also emerged as a central element of multilateral trade relations. One of the objectives of TRIPS Agreement is that "The protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to a balance of rights and obligations".

International laws recognize that there is a relevant nexus between international human rights instruments and intellectual property policies and laws. Newer international intellectual property rights instruments, such as the TRIPS Agreement and the WIPO copyright treaties, do recognize that some balance is required between intellectual property rights and social and economic welfare, public health and nutrition. International law and policymaking should, as a matter of course, be reframed from a human rights perspective. Some major Human Rights Instruments like UDHR can be employed to bind states to design an intellectual property rights system that strikes a balance between promoting general public interests in areas of health, culture and education, whilst protecting the property rights of authors and inventors.

The WTO Agreement distinguishes between the Multilateral Trade Agreements and the Pluri-lateral Trade Agreements. The multilateral trade agreements are binding on all WTO Members and must be ratified, together with the WTO Agreement, as a whole. Pluri-lateral trade agreements are optional in character and only oblige those members which choose to ratify them. The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) is a kind of multilateral trade agreements that creates obligation on a State when it becomes a WTO membership.

The World Intellectual Property Organization (WIPO)-administered systems of international protection significantly simplify the process for simultaneously seeking IP protection in a large number of countries. Rather than filing national applications in many languages, the systems of international protection enable the applicant to file a single application, in one language,

and to pay one application fee. The protection of IPRs in domestic levels of all WTO member States is to ensure their mutual supportive manner and to take into account of public interests and national security interests.

4. Overview of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) and Interpretation of its Provisions

One of the WTO multilateral trade agreements_ the TRIPS Agreement is an attempt to narrow the gaps in the way the IPRs are protected around the world, and to bring the enforcement practices of them under common international rules. It establishes minimum levels of protection that each WTO member has to take responsibility for enforcements the intellectual property rights. In doing so, it strikes a balance between the long term benefits and possible short term costs to society. Society benefits in the long term when intellectual property protection encourages creation and invention, especially when the period of protection expires and the creations and inventions enter the public domain. Governments are allowed to reduce any short term costs through various exceptions, for example to tackle public health problems. And, when there are trade disputes over intellectual property rights, the WTO's dispute settlement system is also available.[1]

The main forum for work on the TRIPS Agreement is the Council for TRIPS which was created by the WTO Agreement to "oversee the functioning" of the TRIPS Agreement.

4.1 Outlines of the TRIPS Agreement Provisions

The TRIPS Agreement is a comprehensive multilateral agreement on intellectual property. It deals with each of the main categories of intellectual property rights, establishes standards of protection as well as rules on administration and enforcement of intellectual property rights, and provides for the application of the WTO dispute settlement mechanism to resolve disputes between Members concerning compliance with its standards. The agreement covers five broad issues:

- how basic principles of the trading system and other international intellectual property agreements should be applied
- how to give adequate protection to intellectual property rights
- how countries should enforce those rights adequately in their own territories
- how to settle disputes on intellectual property between members of the WTO
- special transitional arrangements during the period when the new system is being introduced.[2]

The following is a brief introduction to the various parts of the Agreement. Part I of the TRIPS Agreement sets out general provisions and basic principles of the Agreement, such as national treatment and most-favored-nation treatment, and exhaustion of intellectual property rights. Standards concerning the availability, scope and use of intellectual property rights are stated in Part II of the Agreement as the minimum standards of IP protection to be provided by each Member in the following fields:

(1) copyright and related rights;

(2) trademarks, including service marks;

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[1] WTO, 'Understanding WTO', 5th Edit, 2011, p- 39.
[2] Ibid.

(3) geographical indications;

(4) industrial designs;

(5) patents, including the protection of new varieties of plants;

(6) the layout-designs of integrated circuits; and

(7) undisclosed information, including trade secrets and test data.[1]

The TRIPS Agreement sets these standards firstly by requiring compliance with the substantive obligations of the main conventions of the World Intellectual Property Organization (WIPO), the Paris Convention and the Berne Convention in their most recent versions. The relevant provisions are to be found in Articles 2.1 and 9.1, which relate, respectively, to the Paris Convention and to the Berne Convention.

The TRIPS Agreement is sometimes referred to as a "Berne-plus" and "Paris-plus" agreement. Article 2.2 of the TRIPS Agreement contains a safeguard clause, according to which the provisions of the Agreement cannot be understood to derogate from the existing obligations that Members may have to each other under the Paris Convention, the Berne Convention, the Rome Convention or the IPIC Treaty.

Part III of the TRIPS Agreement deals with domestic procedures and remedies for the enforcement of intellectual property rights. Part IV of the Agreement contains general rules on procedures related to the acquisition and maintenance of intellectual property rights, particularly concerning how applications for IP protection are administered and the kind of appeals or reviews that should be available.[2] Part V of the Agreement deals with dispute prevention and settlement. The Agreement makes disputes between Members about the respect of obligations contained in it subject to the WTO's dispute settlement procedures.[3] Part VI of the Agreement contains provisions on transition periods, transfer of technology and technical cooperation.[4]

Part VII deals with institutional arrangements and certain cross-cutting matters such as the protection of existing subject matter.[5] The WTO Agreement creates a three-tiered organizational structure. The highest tier is the Ministerial Conference, which meets at least once every two years (Article IV.1). It has the authority to take decisions on all matters under the WTO Agreement. The second tier is the General Council, consisting of representatives of all the Members, which is to meet “as appropriate” to carry out its own duties as well as those of the Ministerial Conference in the intervals between meetings of the latter body (Article IV.2). The General Council also serves as the Dispute Settlement Body and the Trade Policy Review Body (Article IV.3 and IV.4).[6]

The WTO Agreement (Article IV.5) also establishes a Council for Trade-Related Aspects of Intellectual Property Rights _the “TRIPS Council” _ which, under the general guidance of the General Council, is to oversee the functioning of the TRIPS Agreement (Article IV.5). Membership in the TRIPS Council is open to representatives of all Members. The TRIPS Council is responsible for monitoring the operation of the TRIPS Agreement and Members’ compliance with the obligations under that Agreement.

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[1] Article 9- 39 of TRIPS Agreement.
[2] Article 62 of TRIPS Agreement.
[3] Article 63- 64 of TRIPS Agreement.
[4] Article 65- 67 of TRIPS Agreement.
[5] Article 68- 73 of TRIPS Agreement.
[6] WIPO, ‘Intellectual Property Handbook’, 2nd Edit, 2004, p- 346.

The TRIPS Agreement is provided for the minimum standards of IPRs protection both in national level and globally linked the national, regional and international IPRs system with the cooperation of legal-technical assistance and other fundamental activities between WTO and WIPO so as to minimize all barriers to free trade and also to maximize the usefulness of these cooperation activities for developing countries.

4.2 Interpretation of TRIPS Agreement

The process of interpretation is a judicial function, whose purpose is to determine the precise meaning of a provision, but which cannot change it. Globalization blurs the boundaries between jurisdictions of law and multiplies the encounters between divergent legalities.

The legal duty that requires that the TRIPS Agreement shall be made effective results not only from the specific consent from the member states to do so, but also from a general rule of international law: -

> "The requirement to implement an international agreement is implicit in the obligation to perform it in good faith."

The well-known principle to perform treaty obligation in good faith ('*pacta sunt servanda'*) is established by Article 26 of the Vienna Convention on the Law of Treaties (VCLT) 1969 as "Every treaty in force is binding upon the parties to it and must be performed by them in good faith." This principle substantially codifies customary international law and becomes the source of international law under Article 38 (1) of the Statute of International Court of Justice.

The good faith requirement mandates a duty to implement the obligations conceived at international level, irrespective of any domestic legal constraints. Article 31 of the Vienna Convention states that "A treaty shall be interpreted in good faith in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose." There shall be taken into account, together with the context:

(a) any subsequent agreement between the parties regarding the interpretation of the treaty or the application of its provisions;

(b) any subsequent practice in the application of the treaty which establishes the agreement of the parties regarding its interpretation;

(c) any relevant rules of international law applicable in the relations between the parties.[1]

Anyhow it denotes that members of WTO shall be free to determine the appropriate method of implementing the provisions of the TRIPS Agreement within their own legal system and practice.[2] The primary rule is that the words of the treaty must be interpreted according to their ordinary meaning. It is important to note that under Article 2 (paragraph 2) of the TRIPS Agreement, "Nothing in Parts I to IV of this Agreement [and Article 9 is in Part II] shall derogate from existing obligations that Members may have to each other under ...the Berne Convention... ".

Consequently, it would seem that a Member of WTO which is not party to the Berne Convention will not have to apply the provisions of the Berne Convention on moral rights and rights derived there from, while a Member of WTO which is party to the Berne Convention will have to apply those provisions, not only with respect to nationals of Members of WTO which are party to the Berne Convention, but also with respect to nationals of Members of WTO which are

[1] Article 31(3) of the Vienna Convention on the Law of Treaties 1969.
[2] Article 1.1 of the TRIPS Agreement.

not party to the Berne Convention (the latter by virtue of the national treatment[1] and most-favored-nation treatment[2] Rules). However, it would seem that disputes concerning the adequacy of moral right protection could not be the subject of WTO dispute settlement procedures since such procedures are in the field of intellectual property only available for disputes under the TRIPS Agreement.[3]

Under the TRIPS Agreement, it gives the member free choice to determine the method of implementing its provisions. Many of the WTO's Appellate Body's decisions did not follow all the customary rules of interpretation of international law and in addition, it mainly focuses on the object and purpose of the treaty as a whole, on the text of the provisions of the treaty and on the intentions of the parties to treaty.

5. Enforcement of Intellectual Property Rights under TRIPS Agreement

Accessible, sufficient and adequately funded arrangements for the protection of rights are crucial in any worthwhile intellectual property system. All intellectual property systems need to be underpinned by a strong judicial system for dealing with both civil and criminal offenses, staffed by an adequate number of judges with suitable background and experience. Intellectual property disputes are in the main matters to be decided under civil law and the judicial system should make every effort to deal with them not only fairly but also expeditiously. Without a proper system for both enforcing rights and also enabling the grant of rights to others to be resisted, an intellectual property system will have no value.

The ability to tailor intellectual property policies to domestic conditions is critical for several reasons. First, intellectual property policies may need to vary by country in order to protect human health and welfare. The debate about access to medicines is perhaps the best-known example of this: depending on its health needs and resources, a state may need to limit patent rights on some kinds of medicines in order to make those medicines affordable. The importance of tailoring intellectual property law to protect human rights extends to all types of intellectual property and all types of rights.[4]

Second, intellectual property policy must be tailored to local conditions in order to promote innovation and development. The intellectual property policies that will foster innovation and development in one context are different from those necessary in another. China, for example, may want strong rights for its software industry but weaker rights for pharmaceuticals in order to ensure sufficient access to medicines and incentivize software production. Data exclusivity can provide incentives for research into traditional medicines in countries that have substantial indigenous knowledge resources. The speed of changes in the digital environment has the potential to make flexibilities just as important for developed nations as they are for developing nations.[5]

Third, intellectual property policies must be tailored to conform to local values and concerns. Intellectual property policies often involve consideration of issues intimately bound up with local values, such as freedom of expression. States may want broader exceptions to copyright for parody or news reporting in order to provide more protection to expression. States with indigenous populations may want more extensive protections for traditional knowledge. Others

[1] Article 3 of the TRIPS Agreement.
[2] Article 4 of the TRIPS Agreement.
[3] WIPO, 'Implications of The TRIPS Agreement on Treaties administered by WIPO', 2012, p - 15.
[4] Molly Land, "Rebalancing TRIPS", 2012, Michigan Journal of International Law, Volume 33, p- 437.
[5] Molly Land, "Rebalancing TRIPS", 2012, Michigan Journal of International Law, Volume 33, p - 437.

with artisanal or local production of specialty goods may want stronger protections for geographic indications.[1]

The TRIPS Agreement contains many supplement standards rather than replacing the earlier standards under major IP Conventions like Berne or Paris. Many of the provisions given under TRIPS are given to provide a higher and minimum level of protection than that required under the former IP Treaties. In order to ensure that TRIPS Agreement commitments entered into by WTO Members are adhered to, national implementing legislation, administrative practice and judicial arrangements must stand up to scrutiny under a set of WTO institutional arrangements 'designed to promote compliance'. The TRIPs Council lies at the heart of these arrangements, with its role of ensuring transparency of implementation and enforcement measures through scrutiny and surveillance.

6. Common Issues relating to the Implementation of TRIPS Agreement

Specific TRIPS and IP issues have been taken up in the WTO as a result of decisions taken collectively by Members to work on them. Developing countries expressed concerns regarding TRIPS' possible effect included as TRIPS treats medicines like any other commodity, but medicines are not ordinary consumer products; Prices will likely be higher for new medicines in countries with no previous patent protection; Generic competition will be delayed in countries with previous patent terms less than twenty years; The local pharmaceutical industry could be weakened, and dependence on developed countries may increase; TRIPS may not improve Research and Development (R&D) decisions regarding treatments for the disease common in poor countries.[2]

One of the debatable points is that one of the functions of a patent is to serve as a financial incentive for creators of inventions that benefit society. However, people living in developing countries and their governments have little purchasing power, which removes real incentive to the global private sector to invest in developing medicines that treat diseases endemic in developing countries—also known as tropical and neglected diseases. Developing countries and nongovernmental organizations have argued that patents on pharmaceuticals in the developing world raise prices and thereby reduce access to lifesaving treatment. In contrast, the research-based pharmaceutical industry and many developed countries have argued that the larger problem in resource-limited countries is an insufficient health service infrastructure.[3]

Another issue concerns with the purpose of patents which is to provide a temporary monopoly to rights holders as a stimulus to inventions and their commercialization. However, it should also be noted that the monopoly right provided by a patent normally only excludes others from making, using or selling that particular invention. It does not prevent competition from other drugs, patented or not, that address the same medical conditions. Other things being equal there is a presumption that the producer of a patented product, through the ability to exclude copies, will attempt to earn a monopoly profit and charge higher prices than would otherwise be the case.[4] In affirming that the TRIPS Agreement, "can and should be interpreted and implemented in a manner supportive of WTO Members' right to protect public health and, in particular, to promote access to

[1] Molly Land, "Rebalancing TRIPS", 2012, Michigan Journal of International Law, Volume 33, p - 438.
[2] Management Sciences For Health, 'Intellectual property and access to medicines', 2012, p- 3.
[3] Ibid.
[4] Commission on Intellectual Property Rights, "Report of the Commission on Intellectual Property Rights, Integrating Intellectual Property Rights and Development Policy", London, September 2002, p- 33

medicines for all", paragraph 4 gives guidance to panels and the Appellate Body for the interpretation of the Agreement's provisions in cases involving public health issues.[1]

Articles 27.3(a) and 30 of the TRIPS Agreement provide further public health-related flexibilities. They allow WTO Members to exclude from patentability therapeutic, surgical and diagnostic methods, and to provide for exceptions to rights conferred by a patent including for research and experimentation, prior use and early working (often known as 'the Bolar exception').[2]

The TRIPS Agreement provided an initial transition period to all WTO members[3] whereby some developing countries were exempted from adopting the bulk of TRIPS provisions[4] until 2000. But there is a condition that a member under transitional period shall guarantee that some degree of any improvement or change in its administrative procedures and practices in consistence with the Agreement Provisions.[5] It is also known as "Standstill" or "Non-Rollback" provision.

Countries that did not grant patents before TRIPS (1994) had another five years to integrate TRIPS provisions into their laws.[6] In 2013, the TRIPS Council agreed to extend the deadline for least developed countries to comply with the bulk of the TRIPS Agreement until 1 July 2021. In February 2015, the Least Developed Countries Group requested that WTO Members extend the period before which the least developed countries are obliged to grant patents and other intellectual property standards under TRIPS to pharmaceuticals until such a time that countries graduate from least developed country status. On 6 November 2015, the TRIPS Council accepted the request but limited its scope until January 2033.

a. Developed countries	1996
b. Developing countries (except those under c)	2000
c. Developing countries that did not grant pharmaceutical product patents prior to TRIPS	2005
d. Least developed countries	2021*
e. Least developed countries to enforce or grant patents and data protection on pharmaceutical products	2033**

*Under Article 66 of TRIPS, LDCs originally had a ten-year transition period to comply with the TRIPS Agreement. In 2005, the transition period was extended by 7.5 years to June 2013 when it was further extended till 2021.

**In 2002, as part of the Doha Declaration on TRIPS and Public Health, LDCs received a waiver from their obligations to grant or enforce patents and test data protection on pharmaceuticals, and of their obligations to provide exclusive marketing rights during the transition period, till 2016.[m]

On 6 November 2015, the TRIPS Council extended the transition period relating to pharmaceutical products to 2033 *(4)*. On 30 November 2015, a further decision was taken to waive the mailbox and exclusive marketing rights requirements *(5)*.

Figure Deadlines for Implementation of the TRIPS Agreement by Countries[7]

[1] Carlos M. Correa, "Doha Declaration on the TRIPS Agreement and Public Health", 2002, p- 3.p -11.
[2] Carlos Correa & Duncan Matthews, Discussion Paper, "The Doha Declaration Ten Years on and Its Impact on Access to Medicines and the Right to Health", 2011, p- 10.
[3] Article 65 of the TRIPS Agreement.
[4] Article 66 of the TRIPS Agreement.
[5] Ar. 65 (5) of the TRIPS Agreement.
[6] Ar. 65 (1, 2) of the TRIPS Agreement.
[7] World Health Organization (2017)

WTO members broadened the discussion on the role of intellectual property plays a driver for more inclusive innovation, and addressed the complex interplay between Intellectual Property and Public interest. At the meeting of the TRIPS Council on 27, February 2018, Members repeated well-known positions regarding the "triplets" issues – the review of Article 27.3(b) with respect to patenting of life forms (Biotechnology), the relationship between the TRIPS Agreement and the Convention on Biological Diversity (CBD) and the protection of traditional knowledge.[1]

Under TRIPS, countries may exclude from patentability plants and animals and essentially biological processes for producing them, but not microorganisms. And they are required to apply some form of protection, either by patents or a sui generis system to plant varieties. The issue raised by TRIPS is what constitutes an invention in relation to genetic material. This is a matter for national legislation. The only specific requirement, other than for microorganisms, is that plant varieties be protected.[2]

Traditional knowledge protection is one of the issues that will debate in the negotiation of the WTO regime. It is also an important concern for many countries including indigenous communities that faced with unauthorized utilization of their traditional knowledge (TKs) based on the genetic resources. Possible reasons for protecting traditional knowledge as:

- Equity considerations – the custodians of traditional knowledge should receive fair compensation if the traditional knowledge leads to commercial gain
- Conservation concerns – the protection of traditional knowledge contributes to the wider objective of conserving the environment, bio-diversity and sustainable agricultural practices
- Preservation of traditional practices and culture – protection of traditional knowledge would be used to raise the profile of the knowledge and the people entrusted with it both within and outside communities
- Prevention of appropriation by unauthorized parties or avoiding “bio-piracy”
- Promotion of its use and its importance to development.[3]

The TRIPS Agreement allows the granting of patents for inventions that use genetic material without requiring that the provisions of the Convention on Biological Diversity (CBD) in relation to prior informed consent and benefit sharing are respected. Two approaches, not necessarily mutually exclusive, have been taken by Members in addressing these and other concerns regarding the mutual supportiveness of the two Agreements. One approach is to use national solutions, including legislation on access and benefit sharing and contracts. The other approach is to advocate some kind of "disclosure" requirement on patent applicants as a supplementary measure to national legislation and contracts (the "disclosure approach").[4]

In the patent application, there should be a condition to provide evidence of prior informed consent, particularly, supplemented by a certified document issued by the concerned government authority or agency, or by a legal contract concluded between the applicant and the national authorities of the country of origin. The principle of fair and equitable sharing of benefits may be implemented by making arrangements and evidenced, at the time of the patent application, of an

[1] www.wto.int
[2] Germán Velásquez, Research Paper 78, ‘Intellectual Property, Public Health and Access to Medicines in International Organizations’, South Center, 2017, Ibid, p- 59.
[3] Ibid, p- 78.
[4] IP/C/W/368/Rev.1, 8 February 2006, p- 13.

existing or future benefit sharing arrangement that is premised upon mutually agreed terms and is fair and equitable in the circumstances. The terms of benefit sharing arrangements would cover elements relating to the conditions, rights and obligations, procedures, types, duration, distribution and mechanisms of the benefits to be shared.

The enforcement of TRIPS Agreement requires an assessment of the level of adjustment expected of developing countries, the degree that TRIPS facilitates technology transfer and the extent of the reward for the contribution of developing countries in terms of biological resources, traditional knowledge and cultural expression. Many developing countries adopted mechanisms that enable greater access to technologies by limiting the scope of protection of IP rights and closely regulating the exercise of such rights. On the other hand, the developed countries pursued policies to secure the protection of their industries' IP rights. This led to tension between developed and developing countries.

7. Incorporation of TRIPS Agreement into Intellectual Property Laws of Myanmar

The strong Intellectual Property system is the essential tool for the emergence and maintenance of innovation and creative environment as well as for the attraction of foreign direct investment in the country. The TRIPS Agreement provides the minimum standards for the protection of IPRs with particular guidance and procedures. Myanmar have been practiced the procedures for the protection and the enforcement of IPRs under the out of date legal system, it urgently needs to protect and extend the protection level of IPRs under the modern IP protection mechanism for being a WTO member. In the early 2019, four main IP laws _Trademark Law, Industrial Design Law, Patent Law and Copyright Law_ have been promulgated by the Pyidaungsu Hluttaw. Even though these laws will be entry into force on the date declared by the President for confirmation, they contain detail provisions for the protection of IPRs in Myanmar in line with the TRIPS Agreement.

7.1 Protection of Trademarks under Trademark Law (2019)

Myanmar Trademark Law was enacted by the Pyidaungsu Hluttaw on 30 January 2019 as the Law No.3/2019. This Law will come into force on such date of confirmation in a Notification by the President. Under Trademark law, it includes 24 Chapters together with 106 Sections.

The main objectives of the law are

- To develop more in investment, trading and commercial activities by protecting the marks;
- To protect the interests of mark owner and right holder/ Proprietors
- To create a fair market competition system and create a safe and secure environment for the public by preventing the entry into the channels of commerce of counterfeit trademarks and counterfeit trademarks goods.
- To improve the quality of products produced in the Union by the protection of Geographical Indications and to develop more the socio-economic life of the local people by penetrating of such goods to the international market.

Under Myanmar Trademark Law, the word 'mark' is firstly defined as personal names, letters, numbers, figurative elements, any visually perceptible sign including combinations of colors as well as combination of such signs that can distinguish the goods or services of one

undertaking from those of others. This also includes trademark, service mark, collective mark and recognized mark.[1]

Again, the word 'trademark' means any mark that can distinguish the goods of one undertaking from those of others. 'Service mark' means any mark that can distinguish the services of one undertaking from those of others. 'Collective mark' means any mark owned by the organization, association or socio-economic organizations which are composed of industrialists, manufactures, or traders; or by the collective organizations like cooperative societies. 'Recognized mark' means any mark recognized by its owner that allow to use such mark under his control regarding the country of origin, quality, type and other distinct characteristics of products or services for which the mark represents. It is provided in Chapter 7 of the Trademark law about the 'non-registrable marks'.

In Chapter 12 of the Trademark Law, it mainly discusses about the rights of registered marks. In Section 38, it provides 'without prejudice to the provisions in sections 36 (good faith use) and 37 (goods on markets already approved by the mark owner), the mark owner has *firstly*, an exclusive right (i) to protect his mark if anyone who carries out the transaction by using a mark similar or identical to his mark in the identical or similar products or services without consent and likelihood of confusing the public, or, (ii) to sue any person who infringe his registered trademark rights under criminal or civil proceedings or with both, or, (iii) to prevent the use of a mark that is similar or identical to his registered well-known marks in different products or services without consent if (1) there may be an indication which show the connection between the mark owner and the goods or services that apply it, or (2) the interests of the mark owner may be impaired, and *secondly*, the right to transfer or assign the trademark rights.

Concerning the term of trademark protection, it is provided in Chapter 11 of the Trademark law. The term of the registered mark is ten (10) years from the date of application for such Mark. After the registration is expired, it may be renewable for another ten (10) years each time.[2]

In Chapter 16 of the Trademark Law, it provides for protection of Geographical Indications. The definition of GIs is provided in Section 2 (o) of such law as "Geographical indications are indications which identify a good as originating in the territory of a Member, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin".

7.2 Protection of Industrial Designs under Industrial Design Rights Law (2019)

Myanmar Industrial Design Rights Law was enacted by the Pyidaungsu Hluttaw as the Law No. 2 on January 30, 2019. This Law will come into force on such date of confirmation in a Notification by the President. Under Industrial Design Rights Law, it includes 24 Chapters together with 87 Sections.

The main objectives of the law are provided in Section 3 of this law as

1. to protect the rights and interests of designer owners and creators,
2. to contribute to the development of industries by protecting industrial design creation,
3. to contribute to the development and propagation of industrial design technology,

[1] Section 2 (j) of the Trademark Law (2019).
[2] Section 34 of the Trademark Law.

4. to benefit mutually the prosperity of technology knowledge and socio-economic lives between the creator and industrial design users.
5. to contribute to the harmonization of the rights and responsibilities between industrial design users and the creators.

The criteria for industrial design for which protection available is provided in Chapter 7 of this Law and it provides in Section 13 as "Protection shall be available for any industrial design that are new and originality". Unless it is either printed, used, published, displayed or disclosed in any way, any industrial design shall be regarded as 'new'. If it is combined with or not significantly different from the features of the industrial design that are commonly known to everyone, any industrial design shall not be regarded as 'new'.

This is provided in Chapter 15 of the Industrial Design Rights Law. Under Section 46, the owner of an industrial design shall be entitled to exclusive right to prevent and protect from making, selling, or importation of products, without his permission, that are featured with or comprised of the Industrial Design that copy the main features of the registered Industrial Design or that copy of the registered industrial design for commercial purpose.

The owner of the registered industrial design shall be entitled to sue any person who infringed his rights by civil proceedings under Section 46 (b) of this law. For the design created by the employee by using the employer materials, the employer may get the authorization upon such design with the non-single permission. When the industrial design is owned by the multiple owners, each owner shall be equally entitled to the undivided rights of the registered industrial design and also each owner has the right to sue the infringer without requiring the approval of other co-owners of same industrial design under Section 48.

Under the provision of Section 49, the industrial design owner cannot use his rights relating to –

(a) transactions for private matters, not for commercial use;

(b) experimental matters or research activities;

(c) re-generating in order to use as a reference or teaching.

The provisions relating to the matters of registration are contained in Chapter 14 of the Industrial Design Rights Law. Under Section 42, the duration of protection to industrial design is 5 years from the date of the application of registration. The registration is renewal for 15 years, each term will last for 5 years.

In Myanmar, so as to in line with TRIPS Agreement, it should be better to provide 10 years protection of industrial design for initial registration and then two additional terms may be allowed for renewal, each term will be covered for 5 years.

7.3 Protection of Patent under Patent Law (2019)

Myanmar Patent Law was enacted by the Pyidaungsu Hluttaw on 11 March 2019 as the Law No.7/2019. This Law will come into force on such date of confirmation in a Notification by the President. Under Patent law, it includes 25 Chapters together with 119 Sections.

Under Section 3, the objectives of this law are

(a) to protect the rights and interests of the patentee and the inventor;

(b) to develop the Union production by enhancing the technical innovations and by disseminating and assigning of technology;

(c) to cause mutual benefits for technology knowledge and social economic development between inventors and users;

(d) to support the balancing of rights and responsibilities between the innovators and users;

(e) to deter the patentee or right holder from misuse of patent and from control of trading unfairly;

(f) to encourage the growth of the innovative environment.

In Section 13 of Chapter 7 of Patent Law, it provides three criteria for being the patentable subject matter. It is also known as 'three-step test' under the TRIPS Agreement. Patents shall, if it is not incompliance with the provisions under Section 14, be protected if (a) new or novelty, (b) inventive step or non-obvious and (c) industrial applicability. It includes detailed provisions on these criteria. With respect to the 'new', an invention is novel unless it has existed as a prior technical invention. The invention shall be regarded to include 'inventive step' if an expert in a particular field of study does not easily understand such invention. The term 'industrial applicability' means the application or utilization of such invention in the industry sectors including those of manufacturing and service providing.

With regard to the exclusion from patentability, it is provided in Chapter 8 of the Patent Law. Under Section 14 of this law, the following types of inventions cannot be protectable:-

(a) discovery, scientific theories and mathematical calculations;

(b) schemes, rules and methods for doing business, performing mental behaviors or playing games;

(c) computer programmes;

(d) essential biological processes for the production of plants or animals except non-biological and microbiological processes;

(e) all creatures, plants and animals covering animals, species and plant varieties whether in part or wholly thereof can be found in nature, DNA and complementary DNA Consequences, Cell Lines and Cell Cultures and Seeds, except created microorganisms;

(f) therapeutic or surgical methods for the treatment of humans or animals including the diagnostic methods gained from the practical testing on human and animal bodies;

(g) naturally existed things and things known to the public including new uses and new features, or inventions related with chemical products;

(h) inventions that can cause prejudice to public morality, tranquility, human beings, animals or plants, or environment impacts, and inventions prohibited to be use within the territory of the Union under any existing law.

The patent owner shall enjoy the rights provided in Section 52 of the Patent Law. As an exclusive right, the patentee has, *firstly*, to prevent any third party from any unauthorized making, using, offering for sale, selling or importing of product patent, and, *secondly*, to protect any third party from any unauthorized use of process patent or act of using such process, and from the acts of: using, offering for sale, selling, or importing for these purposes at least the product obtained

directly by that process. The patent owner has the right to sue the infringer under civil proceedings. And he has the right to assign or transfer his patent rights to any third party.[1]

The term of patent is 20 year from the filing date of the application under Section 47 of the Patent Law. It is compliance with the TRIPS provision that the term of protection shall not end before the expiration of a period of twenty years counted from the filing date under Article 33 of the TRIPS Agreement.

It is provided in Chapter 19 of the Patent Law about the utility model. The criteria of protection of utility model are _ it must be new and be industrial applicable. The term of protection is 10 year from the filing date of application. In Section 87 of this Law, it is not allowed to apply simultaneously either the patent application or utility model application.

7.4 Protection of Copyright under Copyright Law (2019)

Myanmar Patent Law was enacted by the Pyidaungsu Hluttaw on 24 May 2019 as the Law No.15/2019. This Law will come into force on such date of confirmation in a Notification by the President. Under Patent law, it includes 24 Chapters together with 102 Sections.

The objectives contained in the Copyright Law are as follows;

- to promote the production standards related to literary and artistic works by means of working for more development of literary and artistic works, performances, phonogram production and broadcasting.
- to protect the copyrights of literary and artistic works of copyright owners and original creators in accord with this Law.
- to protect and safeguard the rights related to copyright of performers, producers of phonogram and broadcasting organizations.
- to support the protection and uplift the traditional cultural expressions and traditional customary heritages.[2]

According to Section 2 (g) of the Copyright Law, “Copyright” means exclusive right on literary and artistic works that the original creator is entitled under the law. And then in Section 2 (h) of such Law, it defines the “Related Rights” as exclusive rights stipulated in Chapter 13 of the Copyright Law concerning performers, producers of phonogram and broadcasting organizations. The definition of “Literary and Artistic Works” means literary and artistic works and also derivative works described in Section 10 and 12 of this Law.[3] Under Section 2 (j), “Original creator” means the person who first makes or creates any literary and artistic work.

“Copyright owner” means any of following persons, and any heir or inherited organization of that person:-

(1) original creator who has obtained economic right automatically,

(2) the person or legally established organization, rather than original creator, that has automatically and originally obtained economic rights,

[1] Section 52 (b, c) of the Patent Rights Law.
[2] Section 3 of the Copyright Law (Draft).
[3] Section 2 (i) of the Copyright Law (Draft).

(3) the person or legally established organization that economic rights have been legally assigned to as the owner.[1]

However, under Article 9 (1) of the TRIPS Agreement, it excludes to provide protection on moral rights of the creators conferred under Article 6bis of the Berne Convention. It means that the issues concerning the moral rights cannot be settled under dispute settlement mechanism of the WTO. Copyright Law clearly recognizes not only the economic rights but also moral rights of the creators on their works.[2] Under Myanmar Copyright Law, it contains detail provisions concerning the protection of copyrights in Section 10, 11 and for derivative works, it provides in Section 12.

In respect of the term of protection for copyrights and related rights, it is provided in Article 12 of the TRIPS Agreement as "Whenever the term of protection of a work, other than a photographic work or a work of applied art, is calculated on a basis other than the life of a natural person, such term shall be no less than 50 years from the end of the calendar year of authorized publication, or, failing such authorized publication within 50 years from the making of the work, 50 years from the end of the calendar year of making." It is similarly incorporated in Section 15 of the Copyright Law (Draft) but most of the provisions are assumed with reference to Article 7 of the Berne Convention.

7.5 Enforcement Procedures of IP Rights in National IP Laws

In order to supervise the enforcement of IP Rights in Myanmar, the Union Government shall form the Central Committee in accordance with Section 4. It is the central body in Myanmar which performed duties relating to the adoption of IP policies, strategies and schemes; the issuance or rejection of compulsory license; the supervision on the implementation of IP policies, strategies and schemes; and so on. For the administration of IP procedures, the concerned body is the Department. The functions of such department are

- to declare the registration matters concerning IPRs;
- to maintain the registers of intellectual property;
- to supervise the tasks of sub-divisions under separate IP categories;
- to perform the duties assigned by the Agency.[3]

In order to perform the functions relating to the intellectual property at the Department, the Union Ministry (herein referred as the Ministry of Commerce and Finance) can appoint the Registration Officer and the necessary Inspection Officer.

The provisions relating to Appeal is provided in one separate Chapter of each IP Law. Any person who dissatisfies the decision of the Registration Officer may appeal to the Agency within the 60 days from the date of such decision. And any person who dissatisfies the decision of the Agency may appeal to the IP Court within the 90 days from the date of such decision under Section 66 of the Trademark law. But there are no provisions concerning whether the decision of the IP court will be conclusive or not.

The Union Supreme Court may appoint judges by establishing IP Courts in relevant territory to trial the civil proceedings or criminal cases dealing with IPRs and confer powers and jurisdiction to them dealing with such IP matters. Before the establishment of such IP Courts, the

[1] Section 2 (k) of the Copyright Law (Draft).
[2] Chapter 9 of the Copyright Law (Draft).
[3] Section 9 of the Patent Law.

Supreme Court can confer powers and jurisdiction to any other normal courts to trial matters relating to IP. For the infringement of trademark rights, he can also apply to take action either by civil proceedings or by criminal cases. But in the case of infringement of industrial designs and patent, the right holder can only apply to take action by civil proceedings.

All IP Laws in Myanmar contain provisions dealing with the procedures of provisional measures by the judicial authorities. Any right holder of any intellectual property including trademark, industrial design, or patent, may, as for the damage suffered, apply in line with the stipulations to the IP Court to order temporary sanction.

In the case of Trademark protection, for instance, the provisions relating to the role of custom department in the protection of trademark are contained in Chapter 21_from Section 68 to Section 76 of new Trademark Law. The Custom Department shall, whether after accepting the application or whether its own volition, suspend the entering of such goods into the channel of commerce if there are valid reasons and evidence that seem to show such counterfeit trademark products. And it needs to inform immediately to the concerned parties.[1]

Myanmar has an obligation to establish strong and effective intellectual property protection system not only for being a WTO founding member but also for being a member of ASEAN so as to enhance the ASEAN Economic Community (AEC). It still needs to modify existing IP related laws to meet the minimum standards of the TRIPS Agreement that leads to support innovation, creation and foreign investment. After setting up of strong IP protection regime in Myanmar, it will enormously contribute to increase productivity and innovative capacity, to attract more foreign investment and enjoy more job opportunities by local peoples, to expand the market economy, trading and commercial activities via AEC, to create free, fair market competition, and finally to benefit the prosperity of technology, innovation, creation of the creators or right holders, taking into account of third parties' interests and public interests concerns.

Findings and Conclusion

In the history, the legal regime for protection of intellectual property existed apart from the legal regime of real property trade. The time to meet these two issues was the Uruguay Round Negotiations that led to the formation of TRIPS Agreement. It is obvious that the protection of intellectual property rights under the TRIPS Agreement is so as to establish and promote the creations and technological innovations via reward system given to the creators or owners on their works. However, the TRIPS Agreement do recognizes that such protection should contribute not only to the mutual benefit between the inventors and users of these innovations but also to the advantage of economic and social welfare. And it ensures the responsibility of all WTO member States to provide the necessary measures to protect public health and nutrition, and to promote public interests in the fields of vital importance to socio-economic and technological development and also the obligation to applying the principle of balancing nature of private rights and public interests in the interpretation of the provisions contained in the TRIPS Agreement.

In dealing with effective enforcement of intellectual property rights, the TRIPS Agreement provides general obligations including all intellectual property systems need to be underpinned by a strong judicial system for dealing with both civil and criminal procedures, and also for establishing other administrative procedures as border measures requirement. One significant

[1] Section 70 of the Trademark Law.

improvement of the TRIPS Agreement is that IP disputes between WTO members can be settled under the WTO Dispute Settlement Understanding (DSU).

In relation to the implementation of IPRs system under the TRIPS Agreement, there are debatable questions between the developed countries and the developing ones. There are arguments by developed countries that strong Intellectual Property Rights legislation will enable developing countries to attract foreign investment and will thereby gain improved access to basic infrastructures and new technologies by building partnership with business organizations globally. Due to the incentives offered by the IPR protection system, it can be encouraged to generate more innovations of their own by the developing countries.

But many developing countries are resource-limited countries particularly insufficient production ability. They are still reliable on the products produced by the developed countries. The legal standards established by the TRIPS Agreement may be too high for the developing countries especially for patents. The TRIPS Agreement recognizes such kind of problems faced by the developing world, and provides a particular section dealing with the assistance to developing countries. Another concern is that the impact of intellectual property rules and practices in the health of poor people in developing countries has generated substantial controversy in the WTO regime. On the one hand, the pharmaceutical industry in developed countries is strongly dependent on the patent system to generate profits and to fund further research and development (R&D) projects. However, on the other hand, if prices are raised to cover these inputs, it may fall especially hard upon the poor who cannot afford to hindrance accessibility to those patented drugs.

One of the major concerns in the implementation of TRIPS Agreement is that the 'triplet' issues' including _ patenting of life form (Biotechnology), protection of traditional knowledge, and the relationship between Convention on Biological Diversity (CBD) and TRIPS Agreement.

Nonetheless, the TRIPS Agreement gives freedom to national legislation of all WTO member to establish appropriate method of implementing its provisions by building common desiring to reduce distortions and impediments to international trade, and taking into account the need to promote effective and adequate protection of intellectual property rights, and to ensure that measures and procedures to enforcement intellectual property rights do not themselves become barriers to legitimate trade. In order to establish such strong and practical enforcement procedures, the Agreement do recognizes the special needs of the least-developed country Members in respect of maximum flexibilities in the domestic means as well as legal measures in order to create a sound and viable technological base.

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၂၀၁၉ ခုနှစ်အတွက် မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့် သိပ္ပံပညာရှင်အဖွဲ့ဆု အတွက် ပြိုင်ပွဲဝင် ပါရဂူကျမ်း/ သုတေသနအစီရင်ခံစာများ စာရင်း

စဉ်		ပါရဂူကျမ်း/ သုတေသနအစီရင်ခံစာ အမည်	ဘာသာရပ်	ကျမ်းပြုစုသူ
၁	၁	ဒုတိယ ကျော်အောင်စံထား ဆရာတော်၏ ဘာသာစကား အမြင်	Myanmar	ဒေါက်တာ သူရိန်ဝင့်ဝင့်ဟန် လက်ထောက်ကထိက၊ မြန်မာစာ(ဘာသာ)၊ ရန်ကုန် နိုင်ငံခြားဘာသာတက္ကသိုလ်
၂	၂	နေဝင်းမြင့်၏ ဝတ္ထုတိုများမှ ဘာသာစကားဟန်	Myanmar	ဒေါက်တာ ရွှေရည်မြတ်မွန် လက်ထောက်ကထိက၊ မြန်မာစာ(ဘာသာ)၊ ရန်ကုန် နိုင်ငံခြားဘာသာတက္ကသိုလ်
၃	၃	မြန်မာဘာသာစကားရှိ နောက်လိုက်ပစ္စည်းများ*	Myanmar	ဒေါက်တာ ထက်ထက်စိန်ဝင်း ကထိက၊ မြန်မာစာ(ဘာသာ)၊ ရန်ကုန်ပညာရေးတက္ကသိုလ်
၄	၄	ဗန်းမော်တင်အောင်၏ စာပေလမ်းကြောင်း (စာပေ)	Myanmar	ဒေါက်တာ စံပယ်ဖြူထွန်း၊ ကထိက၊ မြန်မာစာ၊ လားရှိုးတက္ကသိုလ်
၅	၅	ရှမ်းသဒ္ဒါလေ့လာချက် (ဘာသာဗေဒ)	Myanmar	ဒေါက်တာ ယဉ်ယဉ်စိုး၊ ကထိက၊ မြန်မာစာ(ဘာသာ)၊ လားရှိုးတက္ကသိုလ်
၆	၆	ဇော်ဂျီ၏ ဗေဒါလမ်း ကဗျာစုနှင့် ရှေးခေတ်ကဗျာစု	Myanmar	ဒေါက်တာ ဇင်ဇင်ဦး တွဲဖက်ပါမောက္ခ မြန်မာစာ လားရှိုးတက္ကသိုလ်
၇	၁	Spatial Analysis of Public Services in Mandalay City	Geography	Dr Swe Swe Win Lecturer, Geography, University of Mandalay
၈	၂	Cultural Changes of Meithei Tribe (Manipuri) in Mandalay and its Environs	Geography	Dr Myint Thida Lecturer, Geography, University of Mandalay
၉	၁	Facebook Use, Attitude Toward Facebook, Self-Esteem and College Adjustment among Monywa University Students*	Psychology	Dr Khin Nwe Sint Lecturer, Psychology, University of Yandanabon
၁၀	၁	Mangrove Conservation Efforts in Myanmar: Ayeyarwady and RaKhine*	International Relations	Dr Hein Myat Thu Tutor, International Relations, University of Yangon

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၁၁	၁	Fabrication and Characterization of Acoustic Absorbers Based on Nanomaterials	Faculty of Natural Science	Dr Ei Shwe Sin Oo Assistant Lecturer, Faculty of Natural Science, University of Computer Studies (Thaton)
၁၂	၂	Synthesis and Characterization of Magnesium Zinc Ferrites	Physics	Dr Sabai Aung Lecturer, Physics, University of Magway
၁၃	၃	Assessment of Naturally Occurring Radionuclides in Coal and Coal Ash Samples From Some Coal Mines in Upper Myanmar	Physics	Dr Ei Mon Mon Thein Lecturer, Physics, University of Magway
၁၄	၄	Synthesis and Photovoltaic Characteristics of $ZnO/TiO_2/GO$ Nanocomposities	Physics	Dr Su Su Lwin Demonstrator, Physics, Myeik University
၁၅	၅	Preparation and Characterization of SnO_2 Nanofiber and Thin Film Photoelectrodes for Dye Sensitized Soler Cells*	Physics	Dr Zayar Pyae Phyo Aung Demonstrator, Physics, Myeik University
၁၆	၁	Heavy Metals (Cadmium, Lead, Chromium) in Domestic Animal Procusts Near Myaung Dagar Industrial Zone of Yangon Region	Zoology	Dr Mang Chin Par Student, Zoology, University of Yangon
၁၇	၂	Molecular Phylogenetic Relationship of Some Asian Elephants Elephas Maximus, Linnaeus, 1758 in Certain Areas of Myanmar	Zoology	Dr Khin Moe Lecturer, Zoology, Yangon University of Education
၁၈	၁	Preventive Measures for the Landslides and Hillside Development along the Thazi-Taunggyi Car-road between Yanmabin and Kalaw*	Geology,	Dr Aung Kyaw Myat Associate Professor, Geology, University of Yangon
၁၉	၂	Sedimentology and Reservoir Potential of Oligocene Clastic Strata in the Southern Part of Minbu Basin, Myanmar	Geology,	Dr Naw Chel Phaw Lecturer, Geology, Bago University
၂၀	၁	Taxonomy and Population Biology of Some Sharks and Rays in Mon Coastal Waters	Marine Science	Dr Myo Min Tun Lecturer, Marine Science, University of Mawlamyine
၂၁	၂	Biology and Culture of Green Mussel *Perna viridis* (Linnaeus, 1758) from Ye Estuary in Mon State*	Marine Science	Dr Win Win Nwe Lecturer, Marine Science, University of Sittway
၂၂	၁	Extraction and Utilization of Essential Oils from Curry Leaves, Betel Leaves and Stalks for Some Food and Cosmetic Products	industrial Chemistry	Dr Nay Yee Nyunt Oo, Assistant Lecturer, industrial Chemistry, East Yangon University

စဉ်		ပါရဂူကျမ်း/ သုတေသနအစီရင်ခံစာ အမည်	ဘာသာရပ်	ကျမ်းပြုစုသူ
၂၃	၂	Isolation of Protein from Different Indigenous Beansd and Its Utilization in Food Industries*	industrial Chemistry	Dr Zar Zar Oo, Lecturer, industrial Chemistry, Yadanabon University
၂၄	၁	The Informal Sector and Migration in Mandalay Metropolitan City	Economics,	Dr Mar Lar Than Professor, Economics, Meiktila University of Economics
၂၅	၂	Organizational Justice and Employee Behavior at Hotels in Myanmar	Commerce	Dr Mya Thett Oo Associate Professor, Commerce, Yangon University of Economics
၂၆	၃	Modelling Residents' Support for Tourism Development with Special Reference to Bagan-Nyaung Oo Area, Myanmar*	Statistics	Dr Hlaing Hlaing Moe, Associate Professor, Statistics, Yangon University of Economics
၂၇	၄	Factors Influencing the Completion of Basic Education Primary Level: A Case Study of Some Primary Schools in Meiktila Township, Myanmar	Statistics	Dr Tin Tin Mar, Lecturer, Statistics, Yangon University of Economics
၂၈	၁	Legal Study on the Interpretation and Implementation of Trips Agreement*	Law	Dr Phyu Phyu Thinn Lecturer, Law, University of Yangon
၂၉	၁	An Analytical Study on Pedagogical Knowledge and Practices of Teacher Eudcators in Education Colleges	Education Theory	Dr Khaing Khin Kyaw Lecturer, Education Theory Sagaing University of Education
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၃၁	၃	An Investigation into Factors Affecting Primary School Children's Awareness and Attitudes towards Environmental Issues in Chaungzone Township	Education Theory	Dr Su Chan Myae Lecturer, Education Theory, Yangon University of Education
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* ဆုရ သုတေသနလုပ်ငန်း အစီရင်ခံစာဖြစ်ပါသည်။

“မြန်မာနိုင်ငံ ဝိဇ္ဇာနှင့်သိပ္ပံပညာရှင်အဖွဲ့ဆု” ရရှိသူ ပုဂ္ဂိုလ်များ၏ ကိုယ်ရေးအကျဉ်း

ဒေါက်တာ ခင်နွယ်ဆင့်၏ ကိုယ်ရေးမှတ်တမ်း

ဒေါက်တာ ခင်နွယ်ဆင့်သည် ရတနာပုံ တက္ကသိုလ်၊ စိတ်ပညာဌာနမှ ကထိက တစ်ဦး ဖြစ်ပါသည်။ ဆရာမသည် စိတ်ပညာဘာသာရပ် နယ်ပယ်တစ်ခုဖြစ်သည့် Social Psychology နယ်ပယ်နှင့် သက်ဆိုင်သော ပါရဂူကျမ်းကို ပြုလုပ်ဆောင်ရွက် တင်ပြခဲ့ပါသည်။ ပါရဂူကျမ်း ခေါင်းစဉ် အမည်မှာ Facebook Use, Attitude Toward Facebook, Self-Esteem and College Adjustment Among Monywa University Students ဖြစ်ပါသည်။ ပါရဂူကျမ်းကို မန္တလေးတက္ကသိုလ်မှ ၂၀၁၉ ခုနှစ်၊ ဇူလိုင်လတွင် အောင်မြင်ခဲ့ပါသည်။

ဒေါက်တာ ဟိန်းမြတ်သူ ၏ ကိုယ်ရေးမှတ်တမ်း

ဒေါက်တာ ဟိန်းမြတ်သူကို အဖ ဦးဝင်းကြည်နှင့် အမိ ဒေါ်ယဉ်ယဉ်မေတို့မှ ၁၉၈၉ခုနှစ်၊ ဩဂုတ်လ၊ (၈) ရက်နေ့ တွင် ရခိုင်ပြည်နယ်၊ သံတွဲမြို့၌ မွေးဖွားခဲ့ပါသည်။ မွေးချင်း (၂)ယောက်တွင် အကြီးဆုံးသား ဖြစ်ပါသည်။

၂၀၀၄ ခုနှစ်တွင် အခြေခံပညာအထက်တန်းကို ရခိုင်ပြည်နယ်၊ သံတွဲမြို့နယ်၊ အ.ထ.က (၁)တွင် အောင်မြင်ခဲ့ပါသည်။ ၂၀၀၅ ခုနှစ်တွင် ဒဂုံတက္ကသိုလ်၊ နိုင်ငံတကာဆက်ဆံရေးပညာဌာနå၌ ပထမနှစ် စတင် တက်ရောက်ခဲ့ပြီး ၂၀၀၈ ခုနှစ်တွင် B.A (IR)ဘွဲ့ကို ရရှိခဲ့ပါသည်။ ၂၀၁၂ ခုနှစ်တွင် M.A (IR) ဘွဲ့နှင့် ၂၀၁၃ ခုနှစ် တွင် M.Res (IR) ဘွဲ့အသီးသီးကို ရရှိခဲ့ပါသည်။ ၂၀၁၅ ခုနှစ်တွင် ရန်ကုန်တက္ကသိုလ်၊ နိုင်ငံတကာဆက်ဆံရေး ပညာဌာနå၌ ပါရဂူဘွဲ့သင်တန်းကို စတင်တက်ရောက်ခဲ့ပါသည်။ ၂၀၁၆ ခုနှစ်တွင် စာရေးသူရေးသားသော **“Mangrove Conservation Efforts in Myanmar: Ayeyarwady and Rakhine”** ပါရဂူကျမ်း အတွက် Nagao Natural Environment Foundation (NEF) Japan မှ ပညာသင်ဆု ရရှိခဲ့ပါသည်။ ပါရဂူဘွဲ့သင်တန်း တက်ရောက်နေစဉ် ၂၀၁၇ ခုနှစ်တွင် ရန်ကုန်တက္ကသိုလ်၊ နိုင်ငံတကာဆက်ဆံရေးနှင့်နိုင်ငံရေးသိပ္ပံဌာနå၌ နည်းပြ အဖြစ် စတင် တာဝန်ထမ်းဆောင်ခဲ့ပါသည်။ ၂၀၁၉ ခုနှစ်တွင် ထိုဌာနမှပင် Ph.D (IR) ဘွဲ့ကို ရရှိခဲ့ပါသည်။ ယခုအခါ ရန်ကုန်တက္ကသိုလ်၊ နိုင်ငံတကာ ဆက်ဆံရေးနှင့်နိုင်ငံရေးသိပ္ပံဌာနတွင် လက်ထောက်ကထိကအဖြစ် တာဝန်ထမ်းဆောင် လျက်ရှိပါသည်။

ဒေါက်တာ ထက်ထက်စိန်ဝင်း၏ ကိုယ်ရေးမှတ်တမ်း

ဒေါက်တာ ထက်ထက်စိန်ဝင်းကို ၁၄.၉.၁၉၈၅ ခုနှစ်တွင် အဖ ဦးစိန်ဝင်း၊ အမိ ဒေါ်အုန်းသန်းတို့မှ ရန်ကုန်မြို့၌ ဖွားမြင်ခဲ့သည်။ ၂၀၀၁ ခုနှစ် အခြေခံပညာ အထက်တန်းကို အောင်မြင်ခဲ့ပြီး ၂၀၀၄ ခုနှစ် တွင် ဝိဇ္ဇာဂုဏ်ထူးဘွဲ့ကို ဒဂုံတက္ကသိုလ်မှ လည်းကောင်း၊ မဟာဝိဇ္ဇာဘွဲ့ကို ၂၀၀၈ ခုနှစ်တွင် ဒဂုံတက္ကသိုလ်မှ လည်းကောင်း ရရှိခဲ့သည်။ ပါရဂူဘွဲ့(မြန်မာစာ)ကို ၂၀၁၉ ခုနှစ်တွင် ရန်ကုန်တက္ကသိုလ်မှ ရရှိခဲ့သည်။ ၂၀၁၂ ခုနှစ်တွင် ရန်ကုန် ပညာရေးတက္ကသိုလ်တွင် နည်းပြအဖြစ် စတင်တာဝန်ထမ်းဆောင်ခဲ့သည်။ ရန်ကုန်ပညာရေး တက္ကသိုလ်တွင် လက်ထောက်ကထိက၊ ကထိကတာဝန်များကို ထမ်းဆောင်ခဲ့ပြီး လက်ရှိတွင် ရန်ကုန်နိုင်ငံခြား ဘာသာတက္ကသိုလ်တွင် ကထိကရာထူးဖြင့် တာဝန်ထမ်းဆောင် နေပါသည်။

ဒေါက်တာ အောင်ကျော်မြတ်၏ ကိုယ်ရေးမှတ်တမ်း

အဖ ဦးမြင့်စန်း၊ အမိ ဒေါ်အေးကြည်တို့မှ ၁၉၇၈ ခုနှစ်၊ စက်တင်ဘာလ (၃) ရက်နေ့တွင် ပဲခူးတိုင်း ဒေသကြီး၊ ပြည်မြို့နယ်တွင် ဖွားမြင်ခဲ့သည်။ မွေးချင်း ၃ ယောက်အနက် ဒုတိယမြောက်သား ဖြစ်ပါ သည်။

မူလတန်းမှ တက္ကသိုလ်ဝင်တန်းအထိ ပြည်မြို့ရှိ ရွှေကူ (အ.မ.က)၊ အ.လ.က (၂)၊ အ.ထ.က (၂) စသည့် ကျောင်းများတွင် ပညာဆည်းပူးခဲ့ပါသည်။ အဋ္ဌမတန်းတွင် သခ်ၤာ၊ အင်္ဂလိပ်စာ နှစ်ဘာသာ ဂုဏ်ထူးဖြင့် အောင်မြင်ခဲ့ပြီး (၁၉၉၅) ခုနှစ်၊ တက္ကသိုလ်ဝင်စာမေးပွဲတွင် သိပ္ပံဘာသာတွဲ ဂုဏ်ထူးဖြင့် အောင်မြင်ခဲ့ပါသည်။

ဒဂုံတက္ကသိုလ်၊ ဘူမိဗေဒဌာနတွင် ဘူမိဗေဒဘာသာရပ် အထူးပြုဖြင့် တက်ရောက်ပညာ ဆည်းပူးခဲ့ပြီး ၂၀၀၄ ခုနှစ်တွင် B.Sc (Hons:) ဘွဲ့ကို ပထမတန်း၊ ပထမဆင့်ဖြင့် အောင်မြင်ရရှိခဲ့ပါသည်။ ၂၀၀၅ ခုနှစ်တွင် ပညာဝန်ကြီးဌာန၊ အဆင့်မြင့်ပညာဦးစီးဌာနအောက်ရှိ မြိတ်တက္ကသိုလ်၊ ဘူမိဗေဒဌာန တွင် သရုပ်ပြတာဝန်ကို စတင်ထမ်းဆောင်ခဲ့ပါသည်။ ၂၀၀၆ ခုနှစ်တွင် ရန်ကုန်တက္ကသိုလ်၊ ဘူမိဗေဒဌာန တွင် မဟာသိပ္ပံဘွဲ့သင်တန်းကို အင်ဂျင်နီယာဘူမိဗေဒဘာသာရပ်အထူးပြုဖြင့် တက်ရောက်ခဲ့ပြီး ၂၀၀၈ ခုနှစ် တွင် M.Sc ဘွဲ့ကို အထူးအောင်ဖြင့် အောင်မြင်ရရှိခဲ့ပါသည်။ ထို့အပြင် ၂၀၁၄ ခုနှစ် တွင်လည်း ရန်ကုန်တက္ကသိုလ်၊ ဘူမိဗေဒဌာနမှဖွင့်လှစ်သော မဟာသုတေသနဘွဲ့သင်တန်းတွင် အင်ဂျင်နီယာ ဘူမိဗေဒဘာသာရပ် အထူးပြုဖြင့် M.Res ဘွဲ့ကို အထူး အောင်ဖြင့် အောင်မြင်ရရှိခဲ့ပါသည်။ ၂၀၁၅ ခုနှစ်တွင် အင်ဂျင်နီယာဘူမိဗေဒဘာသာရပ် အထူးပြုဖြင့် ပါရဂူဘွဲ့ သင်တန်းကို ရန်ကုန်တက္ကသိုလ်၊ ဘူမိဗေဒဌာနတွင် တက်ရောက်ခဲ့ပြီး ပါရဂူဘွဲ့ကျမ်းကို ပြုစုတင်သွင်း ခဲ့သဖြင့် ၂၀၁၉ ခုနှစ်တွင် ပါရဂူဘွဲ့ကို ရရှိခဲ့ပါသည်။ ယနေ့အချိန်အထိ ရန်ကုန်တက္ကသိုလ်၊ ဘူမိဗေဒဌာနတွင် တွဲဖက်ပါမောက္ခ အဖြစ် အလုပ်တာဝန်များကို ထမ်းဆောင်လျက်ရှိပါသည်။

ဒေါက်တာ ဝင်းဝင်းနွယ်၏ ကိုယ်ရေးမှတ်တမ်း

ဒေါက်တာ ဝင်းဝင်းနွယ်ကို အဖ ဦးမင်းအောင် အမိ ဒေါ်စန်းမြ တို့မှ ၁၉၇၇ ခုနှစ်၊ ဩဂုတ်လ (၁၇) ရက်နေ့တွင် ကရင်ပြည်နယ်၊ ကော့ကရိတ်မြို့နယ်တွင် ဖွားမြင်ခဲ့သည်။ မွေးချင်း ၅ ယောက်အနက် တတိယမြောက် သမီးဖြစ်ပါသည်။

မူလတန်းမှ အလယ်တန်းအထိ အ.လ.က (၂)၊ တောင်ပေါ်ရပ်၊ ကော့ကရိတ်တွင် ပညာဆည်းပူးပြီး၊ အဋ္ဌမတန်းတွင် သုံးဘာသာဂုဏ်ထူးဖြင့် အောင်မြင်ခဲ့ပါသည်။ အထက်တန်းပညာကို အ.ထ.က (၁)၊ ကော့ကရိတ်တွင် ပညာဆည်းပူးခဲ့ပြီး (၁၉၉၅) ခုနှစ် တက္ကသိုလ်ဝင်စာမေးပွဲတွင် အထွေထွေသိပ္ပံ ဘာသာရပ် ဂုဏ်ထူးဖြင့် အောင်မြင်ခဲ့ပါသည်။

၁၉၉၆ ခုနှစ်မှ ၂၀၀၈ ခုနှစ် အထိ မော်လမြိုင်တက္ကသိုလ်တွင် ပညာဆည်းပူးခဲ့ပြီး၊ BSc (Honours)၊ MSc နှင့် MRes ဘွဲ့ကို ရရှိခဲ့သည်။ ၂၀၁၂ ခုနှစ်တွင် မော်လမြိုင်တက္ကသိုလ်၊ အဏ္ဏဝါသိပ္ပံဌာနခ၌ သရုပ်ပြ ရာထူးဖြင့် အလုပ်စတင်ဝင်ရောက်ခဲ့သည်။ ၂၀၁၅ ခုနှစ်မှ ၂၀၁၉ ခုနှစ် အထိ ပါရဂူဘွဲ့သင်တန်းကို တက်ရောက်ခဲ့ပြီး ပါရဂူဘွဲ့ကျမ်းကိုပြုစုနိုင်ခဲ့သဖြင့် ၂၀၁၉ ခုနှစ်၊ မေလ တွင် ပါရဂူဘွဲ့ကို ရရှိခဲ့ပါသည်။ ၂၀၁၉ ခုနှစ် ဒီဇင်ဘာလမှ ၂၀၂၁ ခုနှစ် ဇန်နဝါရီလအထိ စစ်တွေတက္ကသိုလ်၊ အဏ္ဏဝါသိပ္ပံဌာနတွင် ကထိကရာထူးဖြင့် တာဝန်ထမ်း ဆောင်ခဲ့ပါသည်။ ၂၀၂၁ ခုနှစ်မှ ယနေ့အထိ မော်လမြိုင်တက္ကသိုလ်၊ အဏ္ဏဝါသိပ္ပံဌာနတွင် ကထိက ရာထူးဖြင့် အလုပ်တာဝန်များကို ထမ်းဆောင်လျက်ရှိပါသည်။

ဒေါက်တာ ဇာဇာဦး၏ ကိုယ်ရေးမှတ်တမ်း

ဒေါက်တာ ဇာဇာဦးသည် ၁၉၈၆ ခုနှစ်၊ မေလ (၁၀) ရက်နေ့တွင် ဦးခင်မောင်မြင့်နှင့် ဒေါ်ခင်ခင်တို့မှ မန္တလေးမြို့တွင် မွေးဖွားခဲ့ပါသည်။ ၂၀၀၂ ခုနှစ်တွင် တက္ကသိုလ်ဝင်တန်း အောင်မြင်ခဲ့ပြီး ၂၀၀၅ ခုနှစ်တွင် BSc(IC) ဘွဲ့၊ ၂၀၀၇ ခုနှစ်တွင် MSc(IC) ဘွဲ့နှင့် ၂၀၁၁ ခုနှစ်တွင် M.Res(IC) တို့ကို ရတနာပုံ တက္ကသိုလ်၊ ကုန်ထုတ်ဓာတုဗေဒဌာနတွင် စတင် တာဝန်ထမ်းဆောင်ခဲ့ပါသည်။ ၂၀၁၉ ခုနှစ်၊ ဧပြီလတွင် ပါရဂူဘွဲ့ကို ရန်ကုန်တက္ကသိုလ်မှ ရရှိခဲ့ပါသည်။ ၂၀၂၀ ခုနှစ်၊ မတ်လ (၂၄) ရက်နေ့မှစ၍ ကထိကရာထူးဖြင့် ရတနာပုံ တက္ကသိုလ်၊ ကုန်ထုတ်ဓာတုဗေဒဌာနတွင် ယနေ့အချိန်ထိ တာဝန်ထမ်းဆောင်လျက်ရှိပါသည်။

ဒေါက်တာဇေယျာပြည့်ဖြိုးအောင်၏ ကိုယ်ရေးမှတ်တမ်း

ဒေါက်တာ ဇေယျာပြည့်ဖြိုးအောင်ကို အဖ ဦးဝင်းလှိုင်၊ အမိ ဒေါ်ရွှေသိန်း တို့မှ ၁၉၈၉ ခုနှစ်၊ ဩဂုတ်လ (၂၄) ရက်နေ့တွင် မွန်ပြည်နယ်၊ သထုံမြို့နယ်၊ ကျိုက္ကော်ကျေးရွာတွင် မွေးဖွားခဲ့သည်။ မွေးချင်း မရှိ တစ်ဦးတည်း သော သားဖြစ်သည်။

ဘားအံမြို့ အမှတ် (၁၁) အခြေခံပညာ မူလတန်းကျောင်းတွင် မူလတန်းပညာကို လေ့လာဆည်းပူးခဲ့ပြီး၊ အလယ်တန်း နှင့် အထက်တန်းပညာကို ဘားအံမြို့ အမှတ် (၄) အခြေခံပညာ အထက်တန်းကျောင်းတွင် ဆက်လက်လေ့လာဆည်းပူးခဲ့ကာ တက္ကသိုလ်ဝင်တန်းကို ၂၀၀၅ ခုနှစ်တွင် သိပ္ပံဘာသာတွဲ ဖြင့်ဖြေဆို အောင်မြင်ခဲ့ ပါသည်။

အဆင့်မြင့်ပညာကို ဘာအံတက္ကသိုလ်တွင် ရူပဗေဒဘာသာရပ် အထူးပြုဖြင့် လေ့လာဆည်းပူးခဲ့ပြီး ၂၀၀၉ ခုနှစ်တွင် BSc (Q) (Physics) ဘွဲ့ ၊ ၂၀၁၃ ခုနှစ်တွင် MSc (Physics) ဘွဲ့ နှင့် ၂၀၁၄ ခုနှစ်တွင် MRes (Physics) ဘွဲ့ တို့ကို ရရှိခဲ့သည်။ ၂၀၁၅ ခုနှစ်တွင် ရန်ကုန်တက္ကသိုလ်တွင် ဖွင့်လှစ်သော ပါရဂူသင်တန်းကို တက်ရောက်ခဲ့ပြီး ပါရဂူဘွဲ့ယူကျမ်းကို ပြုစုနိုင်ခဲ့သဖြင့် ၂၀၁၉ ခုနှစ်တွင် ပါရဂူဘွဲ့ (PhD) ကို ရရှိခဲ့ပါသည်။ သုတေသနစာတမ်းပေါင်း (၉) စောင်ကို ရေးသားထုတ်ဝေခဲ့ပါသည်။ ထို့အပြင် သုတေသနစာတမ်းပေါင်း (၇) စောင်တွင်လည်း ပူးတွဲ စာတမ်းပြုစုသူအဖြစ် ပါဝင်ရေးသားထုတ်ဝေခဲ့ပြီးဖြစ်သည်။ ၂၀၁၇ ခုနှစ်တွင် မြန်မာနိုင်ငံဝိဇ္ဇာနှင့် သိပ္ပံပညာရှင် များအဖွဲ့ မှကြီးမှူးကျင်းပသော (၁၇) ကြိမ်မြောက်သုတေသနစာ တမ်းဖတ်ပွဲတွင် ရူပဗေဒဘာသာရပ်အတွက် အကောင်းဆုံးသုတေသနစာတမ်းဆုကို ရရှိခဲ့သည်။ ၂၀၁၈ ခုနှစ်တွင် မြိတ်တက္ကသိုလ်တွင် ကျင်းပသော တက္ကသိုလ်အဆင့် အကောင်းဆုံးစာတမ်းဖတ်ပွဲတွင် သိပ္ပံဘာသာရပ်အတွက် အကောင်းဆုံးစာတမ်းဆုကို ရရှိခဲ့သည်။ ၂၀၁၉ ခုနှစ်တွင် စစ်တက္ကသိုလ် စာပေ (၂) တွင် ကျင်းပပြုလုပ်သော Conference on Science and Technology Development တွင် သိပ္ပံနှင့်နည်းပညာနယ်ပယ်အတွက် အကောင်းဆုံးသုတေသနစာတမ်း ဆုကို ထပ်မံ ရရှိခဲ့ပါသည်။ ၂၀၁၇ ခုနှစ်တွင် မြိတ်တက္ကသိုလ် ရူပဗေဒဌာနတွင် သရုပ်ပြရာထူးဖြင့် စတင်ဝင်ရောက် လုပ်ကိုင်ခဲ့ပြီး၊ လက်ထောက်ကထိကရာထူးဖြင့် လက်ရှိအချိန်ထိ လုပ်ငန်း တာဝန်များ ဆက်လက် ထမ်းဆောင် လျက်ရှိပါသည်။

ဒေါက်တာ လှိုင်လှိုင်မိုး၏ ကိုယ်ရေးမှတ်တမ်း

ဒေါက်တာလှိုင်လှိုင်မိုးကို အဖ ဦးဌေးအောင်၊ အမိ ဒေါ်စန်းစန်းဝင်းတို့မှ ၁၉၈၀ခုနှစ်၊ ဩဂုတ်လ (၂၀) ရက်နေ့တွင် မန္တလေးတိုင်းဒေသကြီး၊ မဟာအောင်မြေမြို့နယ်၌ မွေးဖွားခဲ့ပါသည်။

ဒေါက်တာလှိုင်လှိုင်မိုးသည် ၁၉၉၇ခုနှစ် တက္ကသိုလ်ဝင်စာမေးပွဲ၌ သချိုာနှင့် အထွေထွေသိပ္ပံ ဘာသာရပ်များတွင် ဂုဏ်ထူးဖြင့် အောင်မြင်ခဲ့ပါသည်။ ၂၀၀၄ခုနှစ်တွင် B.Econ (Hons) (Statistics) ဘွဲ့ကို မုံရွာစီးပွားရေးတက္ကသိုလ်မှ လည်းကောင်း၊ ၂၀၀၇ ခုနှစ်တွင် M.Econ (Statstics) ဘွဲ့ကို မိတ္ထီလာစီးပွားရေး တက္ကသိုလ်မှ လည်းကောင်း၊ ၂၀၁၉ ခုနှစ်တွင် စာရင်းအင်းပညာပါရဂူဘွဲ့ Ph.D.(Statistics) ကို ရန်ကုန်စီးပွားရေးတက္ကသိုလ်မှ လည်းကောင်း အသီးသီးရရှိခဲ့ပါသည်။

ဒေါက်တာလှိုင်လှိုင်မိုးသည် မိတ္ထီလာစီးပွားရေးတက္ကသိုလ်၊ စာရင်းအင်းပညာဌာနတွင် ၂၀၀၅ခုနှစ်၊ ဩဂုတ်လ (၃၁)ရက်နေ့မှ စတင်၍နည်းပြအဖြစ် တာဝန်ထမ်းဆောင်ခဲ့ပြီး မန္တလေး အဝေးသင်တက္ကသိုလ်နှင့် ရန်ကုန်စီးပွားရေးတက္ကသိုလ် တို့တွင်လည်း တာဝန်ထမ်းဆောင်ခဲ့ပါသည်။ ယခုအခါ ရန်ကုန်စီးပွားရေးတက္ကသိုလ်၊ အသုံးချစာရင်းအင်းပညာဌာနတွင် ပါမောက္ခ(ဌာနမှူး) အဖြစ် အလုပ်တာဝန်များကို ထမ်းဆောင်လျက်ရှိပါသည်။

ဒေါက်တာလှိုင်လှိုင်မိုးသည် နိုင်ငံအကျိုးပြု၊ ဘာသာရပ်အကျိုးပြု သုတေသနစာတမ်းများ စွာကိုလည်း ပြုစုရေးသားလျက် ရှိပါသည်။

ဒေါက်တာ ခိုင်ရည်မွန်၏ ကိုယ်ရေးမှတ်တမ်း

ဒေါက်တာ ခိုင်ရည်မွန်ကို အဖ ဦးလှရီ, အမိ ဒေါ်သန်းသန်းကြွေယ်တို့မှ ၁၉၈၈ ခုနှစ်၊ စက်တင်ဘာလ (၂၆) ရက်နေ့တွင် ဧရာဝတီတိုင်းဒေသကြီး၊ ကျိုက်လတ်မြို့နယ်တွင် ဖွားမြင်ခဲ့သည်။ မွေးချင်း (၂) ဦးရှိသည့်အနက် အကြီးဆုံး သမီးဖြစ်ပါသည်။

မူလတန်းပညာကို အ-မ-က (၈) ကျိုက်လတ်တွင် ဆည်းပူးခဲ့ပြီး၊ အလယ်တန်းမှ တက္ကသိုလ်ဝင်တန်းအထိ အ-ထ-က (၂)၊ ကျိုက်လတ်တွင် ဆည်းပူးသင်ယူခဲ့ပါသည်။ ၂၀၀၄ ခုနှစ်၊ တက္ကသိုလ်ဝင်တန်း စာမေးပွဲတွင် အင်္ဂလိပ်စာ၊ ဓာတုဗေဒနှင့် ဇီဝဗေဒ ဘာသာရပ်တို့ကို ဂုဏ်ထူးဖြင့် အောင်မြင်ခဲ့ပါသည်။

၂၀၀၄ ခုနှစ်မှ ၂၀၀၈ ခုနှစ်အထိ ရန်ကုန်ပညာရေးတက္ကသိုလ်တွင် ပညာဆည်းပူးခဲ့ပြီး B.Ed ဘွဲ့ကို ရရှိခဲ့သည်။ ၂၀၀၉ ခုနှစ်တွင် အ-ထ-က (၂)၊ ကျိုက်လတ်တွင် အလယ်တန်းပြ ဆရာမအဖြစ် အလုပ်စတင် ဝင်ရောက်ခဲ့သည်။ ၂၀၁၀ ပြည့်နှစ်တွင် မဟာပညာရေးဘွဲ့ သင်တန်းတက်ရောက်ခဲ့ပြီး ၂၀၁၂ ခုနှစ်တွင် M.Ed ဘွဲ့ ရရှိခဲ့သည်။

၂၀၁၂ ခုနှစ်တွင်၊ စစ်ကိုင်းတိုင်းဒေသကြီး၊ စစ်ကိုင်းပညာရေးတက္ကသိုလ်တွင် နည်းပြအဖြစ် စတင် တာဝန်ထမ်းဆောင်ခဲ့ပြီး၊ ၂၀၁၄ ခုနှစ်တွင်၊ ရန်ကုန်ပညာရေးတက္ကသိုလ်သို့ ပြောင်းရွှေ့တာဝန်ထမ်းဆောင်ခဲ့သည်။ ၂၀၁၄ ခုနှစ်တွင် ပညာရေးပါရဂူဘွဲ့ သင်တန်းတက်ရောက်ခဲ့ပြီး၊ ပါရဂူဘွဲ့ကျမ်းကို ပြုစုနိုင်ခဲ့သဖြင့် ၂၀၁၉ ခုနှစ်တွင် ပါရဂူဘွဲ့ ရရှိခဲ့ပါသည်။

၂၀၁၆ ခုနှစ်မှ ၂၀၁၉ ခုနှစ်အထိ၊ လက်ထောက်ကထိက အဖြစ်လည်းကောင်း၊ ၂၀၁၉ မှ ၂၀၂၁ ခုနှစ်အထိ ကထိက အဖြစ်လည်းကောင်း၊ ရန်ကုန်ပညာရေးတက္ကသိုလ်တွင် တာဝန်ထမ်းဆောင်ခဲ့ပါသည်။

ဒေါက်တာ ဖြူဖြူသင်း၏ ကိုယ်ရေးမှတ်တမ်း

ဒေါက်တာ ဖြူဖြူသင်း ကို အဖ ဦးကျော်စိုး နှင့် အမိဒေါ်သန်းနွဲ့တို့မှ ၁၉၈၈ ခုနှစ်၊ ဧန်နဝါရီလ (၁၁) ရက်နေ့တွင်၊ တိုက်ကြီးမြို့နယ်၊ ရန်ကုန်တိုင်းဒေသကြီး၌ မွေးဖွားခဲ့ပါသည်။ မွေးချင်း နှစ်ယောက်တွင် အကြီးဆုံး သမီးဖြစ်ပါသည်။

၂၀၀၅ ခုနှစ်တွင် အခြေခံပညာအထက်တန်းကို ရန်ကုန်တိုင်းဒေသကြီး၊ တိုက်ကြီးမြို့နယ်၊ အ ထ က.(၁) တွင်အောင်မြင်ခဲ့ပါသည်။ ၂၀၀၆ ခုနှစ်တွင် ဒဂုံတက္ကသိုလ်၊ ဥပဒေပညာဌာနတွင် ပထမနှစ် စတင်တက်ရောက်ခဲ့ပြီး၊ ၂၀၀၉ ခုနှစ်တွင် LLB ဘွဲ့ကို ရရှိခဲ့ပါသည်။ ၂၀၁၂ ခုနှစ်တွင် ဒဂုံတက္ကသိုလ်၊ ဥပဒေပညာဌာနခွဲ နည်းပြအဖြစ် စတင် တာဝန်ထမ်းဆောင်ခဲ့ပြီး၊ ထိုနှစ်တွင် LLM ဘွဲ့ကို လည်းကောင်း၊ ၂၀၁၃ ခုနှစ်တွင် M.Res (Law) ဘွဲ့ကိုလည်းကောင်း ရရှိခဲ့ပါသည်။ ၂၀၁၄ ခုနှစ်တွင် ရန်ကုန်တက္ကသိုလ်၊ ဥပဒေပညာဌာနခွဲ ပါရဂူဘွဲ့ကြို သင်တန်းကို စတင်တက်ရောက်ခဲ့ပြီး ၂၀၁၉ ခုနှစ်တွင် Ph.D (Law) ဘွဲ့ကို ရရှိခဲ့ပါသည်။ ယခုအခါ ရန်ကုန်တက္ကသိုလ်၊ ဥပဒေပညာဌာနတွင် ကထိက အဖြစ် တာဝန်ထမ်းဆောင်လျက် ရှိပါသည်။