



2020

# Engineering Research Project Guidebook – Thesis Writing *Version 3*



**Engr. Reynaldo Perez-Ramos, PhD**  
College of Engineering and Technology  
ROMBLON STATE UNIVERSITY

**MIMAROPA Region**  
**PHILIPPINES**

**VERSION 3**

9/1/2020

## **DISCLAIMER FOR USE:**

*This document is a draft copy of the guidelines that serves as reference in the final preparation of the proposal and submission of the thesis. This is only intended for the 4<sup>th</sup>/5<sup>th</sup> year students of the College of Engineering and Technology of the Romblon State University who are taking-up the subject, Research Projects 1 and 2.*

*This document as a reference material is allowed for academic purposes only. However, commercial reproduction in any form (printing and digital formats) requires prior approval of the author.*

*Write your comments to:*

**ENGR. REYNALDO PEREZ-RAMOS, PhD**  
**Associate Professor**  
**College of Engineering and Technology**  
**Romblon State University**  
**Odiongan, Romblon**  
**Philippines**  
**Email: [rsu.rpramos@gmail.com](mailto:rsu.rpramos@gmail.com)**  
**Website: [www.rsucivilengineering.weebly.com](http://www.rsucivilengineering.weebly.com)**

**Copyright Version 3: September 2020**

**THERMAL AND ACOUSTIC PROPERTIES OF TIGER GRASS POLLEN  
INSULATON MATERIAL WITH ARROWROOT STARCH AS BINDER**

**JONAL VAL T. CASIDSID  
CHAIRMAINE F. FESARILLO  
DONNA F. FORNEA  
KOEN KATE S. GADO  
MARY JOY S. GONZALES  
SAHRA MAE F. PASTOR**

**JANUARY 2021**

**Top Margin: 1.5"**

Arial 12 font size, centered, bold letters

**THERMAL AND ACOUSTIC PROPERTIES OF TIGER GRASS POLLEN  
INSULATON MATERIAL WITH ARROWROOT STARCH AS BINDER**

**Right Margin: 1"**

6 single spacing, 12 font size

**Left Margin: 1.5"**

**A Thesis Presented to the  
Faculty of the College of Engineering and Technology  
Romblon State University  
Odiongan, Romblon**

6 single spacing, 12 font size

**In Partial Fulfilment of the Requirements for the Degree of  
BACHELOR OF SCIENCE IN CIVIL ENGINEERING**

**By:**

1 single spacing, 12 font size, centered

**Jonal Val T. Casidsid  
Chairmaine F. Fesarillo  
Donna F. Fornea  
Koen Kate S. Gado  
Mary Joy S. Gonzales  
Sahra Mae F. Pastor**

1 single spacing, 12 font size, centered

**January 2021**

**Bottom Margin: 1"**

Top margin: 1.5"

Left Margin: 1.5"  
Justified, single spacing

**APPROVAL SHEET**

2 double spacing, 12 font size, justified

The thesis entitled, "TITLE OF THE STUDY IN CAPITAL LETTERS", prepared and submitted by NAMES OF THE STUDENT RESEARCHERS (COMPLETE SURNAME, FIRST NAME INITIALS, MIDDLE INITIALS) IN CAPITAL LETTERS, in partial fulfilment of the requirements for the degree of BACHELOR OF SCIENCE IN CIVIL ENGINEERING is hereby accepted for oral examination.

ENGR. ORLEY G. FADRIQUEL  
Chairman, Panel of Examiners

ENGR. BILSHAN SERVANEZ, PhD  
Member, Panel of Examiners

Right Margin: 1"

ENGR. JASON F. RUFON, MAPA  
Member, Panel of Examiners

ENGR. APRILLE ANN M. SIM, M'Eng  
Member, Panel of Examiners

ENGR. RAYMOND JAY G. SEVERO  
Member, Panel of Examiners

ENGR. REYNALDO P. RAMOS, PhD  
Adviser

Accepted in partial fulfilment of the requirements for the degree of BACHELOR OF SCIENCE IN CIVIL ENGINEERING.

ENGR. APRILLE ANN M. SIM, M'Eng  
Chairman, Civil Engineering Department

ENGR. ALFREDO F. FORTU, PhD  
Dean, College of Engineering and Technology

Date: \_\_\_\_\_

Bottom margin: 1"

**ACKNOWLEDGMENT**

Top margin: 1.5"

iii

Paging, bold

2 double spacing, 12 font size, justified,

The students would like to express their gratitude and since thanks to the people who assisted and guided them in making this research proposal successful.

**(LIMIT TO ONE PAGE ONLY).**

Left Margin: 1.5"

Right Margin: 1"

Casidsid, J. T.  
Fesarillo, C. F.  
Fornea, D. F.  
Gado, K. S.  
Gonzales, S. F.

Bottom margin: 1"

Left Margin: 1.5"

Top margin: 1.5"

iv  
Right Margin: 1"

**TABLE OF CONTENTS**

2 double spacing, 12 font size, justified

<b>Contents</b>		<b>Page</b>
<b>TITLE PAGE</b>		i
<b>APPROVAL SHEET</b>		ii
<b>ACKNOWLEDGMENT</b>		iii
<b>TABLE OF CONTENTS</b>		iv
<b>LIST OF TABLES</b>		v
<b>LIST OF FIGURES</b>		vi
<b>LIST OF APPENDICES</b>		vii
<b>ABSTRACT</b>		viii
<b>CHAPTERS</b>		
<b>I INTRODUCTION</b>		
Background of the Study		1
Objective of the Study		3
Significance of the Study		4
Scope and Delimitation of the Study		6
<b>II REVIEW OF RELATED LITERATURE</b>		
Related Literature		7
Related Studies		10
Conceptual Framework		11
Definition of Terms		13
Hypothesis of the Study (if applicable)		14
<b>III MATERIALS AND METHODS</b>		
Materials and Equipment		16
Methodology and Procedures		18
Research Locale and Time of Study		20
<b>IV RESULTS AND DISCUSSION</b>		
Result of the Experiment		22
Statistical Data and Result		23
Testing Performance		26
Financial Analysis (if applicable)		30
<b>V SUMMARY, CONCLUSIONS AND RECOMMENDATION</b>		
Summary		31
Conclusion		32
Recommendation		35
<b>REFERENCES</b>		36
<b>APPENDICES</b>		

Use Tab for alignment, single spacing

Bottom margin: 1"

Top margin: 1.5"

Left Margin: 1.5"

### LIST OF TABLES

2 double spacing, 12 font size, center

	<b>Title</b>		<b>Page</b>
Table 1	List of Materials		16
Table 2	List of Equipment		17
Table 3	Mixture of the Samples		22
Table 4	Test Results of Compressive Strength		23
Table 5	Test Results of Water Absorption		24
Table 6	Mean Values of Test Results		25

double spacing, 12 font size, justified

Indent, 1 Tab

Use Tab for alignment

Right Margin: 1"

Bottom margin: 1"



Top margin: 1.5"

Left Margin:

**LIST OF FIGURES**

2 double spacing, 12 font size, justified

<b>Figure</b>	<b>Title</b>	<b>Page</b>
Figure 1	Input-Output-Process	2
Figure 2	Materials Used	16
Figure 3	Grinding of Rice Husk Ash	17
Figure 4	Mixing of Materials	20
Figure 5	Comparison of the Performance	26

Indent, 1 Tab

Use Tab for alignment

Right Margin: 1"

Bottom margin: 1"

Top margin: 1.5"

**LIST OF APPENDICES**

2 double spacing, 12 font size, justified

Left Margin: 1.5"

<b>Appendix</b>	<b>Title</b>	<b>Page</b>
Appendix A	Input-Output-Process	11
Appendix B	Materials Used	16
Appendix C	Grinding of Rice Husk Ash	17
Appendix D	Mixing of Materials	20
Appendix E	Comparison of the Mixtures and Performance	26

Indent, 1 Tab

Use Tab for alignment, single space

Right Margin: 1"

Bottom margin: 1"

Title,  
centered,  
bold, Arial,  
12 font size

**THERMAL AND ACOUSTIC PROPERTIES OF TIGER GRALSS POLLEN  
INSULATION MATERIAL WITH ARROWROOT AS BINDER**

Top margin: 1.5"

2 double spacing, 12 font size

single spacing, 12 font size

Jonal Val T. Casidsid  
Chairmaine F. Fesarillo  
Donna F. Fornea  
Koen Kate S. Gado  
Mary Joy S. Gonzales  
Sahra Mae F. Pastor

doublespacing, 12 font size

**ABSTRACT**

double spacing, 12 font size

The abstract is a brief and concise descriptive summary of the study which contains the statement of the problem or the main objective of the study, research design, significance of the study, research instruments, techniques, data gathering procedure, data processing method, findings, conclusions, and recommendations.

**LIMIT TO 1-2 PAGES FOR THE ABSTRACT. MAXIMUM OF 250 WORDS.**

Left Margin: 1.5"

Right Margin: 1"

Bottom margin: 1"

Top margin: 1.5"

**CHAPTER I**

Indent, 1 Tab, justified

2 double spacing, 12 font size, justified

**INTRODUCTION**

This chapter presents the background of the study, objectives of the problem, significance of the study, scope, and limitation of the research study.

2 double spacing, 12 font size

**BACKGROUND OF THE STUDY**

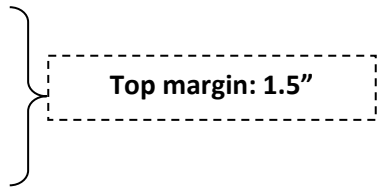
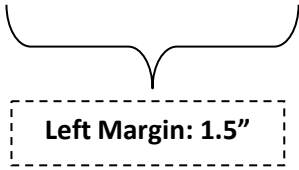
This section of the report provides the overview discussion of the study, particularly the research problem – the “rationale” (basis, motivation, justification) of doing the research. Highlights of the related literature review are included in this section by citing important phrases and sentences from relevant secondary sources of information. This will also provide the reader general idea and impression about the topic under study (Ramos, 2015; Perez, et al., 2011).

2 double spacing, 12 font size

**STATEMENT OF THE PROBLEM/OBJECTIVES OF THE STUDY**

The statement of the research problem must be brief but comprehensive and should have practical importance. A good problem statement is concerned with relation between two or more variables. It is stated clearly without ambiguity and is capable of empirical testing. Thus, the statement of the problem is in a simple language. It is specific, clear and limited. It directs the researcher and the research process, and suggests a specific answer or conclusion. It is the “verbalization of the “questions” which the study proposes to answer.

Bottom margin: 1"



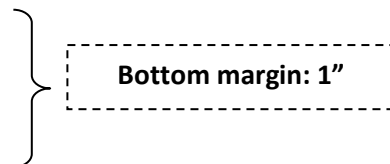
On the other hand, the main objective of the research study is a statement of purpose because this is the guide to be accomplished by the researcher in conducting the research.

**Example A:** The main objective is to analyze and evaluate the electrical system of the main campus of Romblon State University (RSU). Specifically, it attempts to achieve the following research objectives:

- (1) To calculate the total load capacity of the transformers that can hold the power requirements of the RSU-main campus;
- (2) To calculate the total power rating used in the university; and
- (3) To determine the maximum and minimum loading capacities used in the university.

**Example B:** This study aims to design and develop an inlet valve using Bluetooth technology. In particular, the study attempts to answer the following research questions:

- (1) What is the distance of the blue-valve from the Bluetooth technology for water supply control system application in both residential and commercial buildings?
- (2) What is the cost in the application of Bluetooth technology for water supply control system?
- (3) What the level of performance of the developed water supply control system?



Top margin: 1.5"

3

Right Margin: 1"

Left Margin: 1.5"

## SIGNIFICANCE OF THE STUDY

This section of the report explains the contributions of the study either to a body of scientific knowledge, to practitioners/researchers in the same area of the research, or to any other group (students, local community, etc.) which benefit from the outcomes or results of the study. In other words, this answers the following questions: Why is it important for the research study to be conducted? Who will benefit from it, and what benefits could be derived from the results of the study? The research should clearly explain the intention of the researcher, the relevance, and the important implications of the study in solving a problem or a need of the society or community, knowledge gaps, or enriching existing research instruments and methods.

2 double spacing, 12 font size, justified

## SCOPE AND LIMITATION OF THE STUDY

This section explains the coverage or extent of the study area, the subject being focused by the study, the research instruments or methods, duration of the study, and the constraints or limitations that have direct implication on the result of the study. It provides the overall condition of the study in terms of scope and restriction that will have a substantial bearing on the result of the study. ***(De)limitation*** of the study if there will be deviations from the previous scope or coverage due to unavoidable circumstances during the actual conduct of the study.

Bottom margin: 1"

Top margin: 1.5"

No page #

## CHAPTER II

Indent, 1 Tab, justified

2 double spacing, 12 font size, centered, justified

### LITERATURE REVIEW

This chapter presents the legal bases, literature, and studies which are relevant to the research study. The main purposes of the literature review are (a) to determine the similarities and differences of the on-going study and past studies; (b) to acquire additional insights and ideas related to the problem being addressed in the study. Observe proper referencing or citation of the sources of information, using the American Psychological Association (APA) styles to avoid copying or "plagiarism" or infringement. Plagiarism is a violation of Republic Act 8293 known as the Intellectual Property Code of the Philippines. This act provides legal basis in proper use of passages, writings, ideas and statements of other authors/writers by giving due credit of their work.

2 double spacing, 12 font size, centered, justified

### RELATED LITERATURE

This sub-section of the literature review covers those related literature from published articles, books, journals that have connection or linkages to the study conducted.

2 double spacing, 12 font size, justified, centered

### RELATED STUDIES

The sub-section covers published and unpublished research works which are related to the study, specifically highlighting significant findings, conclusions and recommendations from these related studies.

Bottom margin: 1"



Top margin: 1.5 "

According to Ramos (2015), it is necessary to highlight the significant findings from these researches that have similarities and differences to the on-going study.

The present or current and latest related studies are presented first, then following by those past ones (Ramos, 2015; Abad et al., 2014). Ensure that sub-headings are properly labelled as to guide the readers in the flow of the discussion.

Citing references in text should follow the 6<sup>th</sup> Edition of the Publication Manual of the American Psychological Association (APA, 2010) which can be retrieved from:

<http://lumenjournals.com/wp-content/uploads/2017/08/APA6thEdition.pdf>.

There are other existing online sources for proper citation and referencing as your guide such as follows:

[http://student.ucol.ac.nz/library/onlineresources/Documents/APA\\_Guide\\_2017.pdf](http://student.ucol.ac.nz/library/onlineresources/Documents/APA_Guide_2017.pdf)

[http://www.muhlenberg.edu/library/reshelp/apa\\_example.pdf](http://www.muhlenberg.edu/library/reshelp/apa_example.pdf)

<http://umclibrary.crk.umn.edu/apa6thedition.pdf>

<https://aewintecsifinity.blob.core.windows.net/sifinity-storage/docs/default-source/study-at-wintec/apa.pdf>

REMEMBER ALWAYS! Be consistent that all cited in the text should be included in the reference list. Without quoting someone's ideas or words means that using others as your own is not allowed.

Finally, remember that:

- (a) Citation in text with one author, only the surname of the author is enclosed in parentheses (Ramos, 2018)



Bottom margin: 1.5 "



(b) Citation in text with two authors, all surnames of the authors are enclosed in parentheses (Ramos and Perez, 2018)

(c) Citation in text with four or more authors, only the first author's surname is enclosed in parentheses (Ramos, et al., 2018)

2 double spacing, 12 font size, justified

### CONCEPTUAL FRAMEWORK

This section explains both the theoretical and conceptual framework of the study. It gives a clear discussion regarding the research paradigm used in the conduct of the study. A typical model is the **INPUT-PROCESS (THROUGHPUT)-OUTPUT** which constitutes the flow of the activities, including the relationship of selected variables as shown in the figure below. A brief discussion for each process is required to have clearer understanding of the research methodology employed in the study.

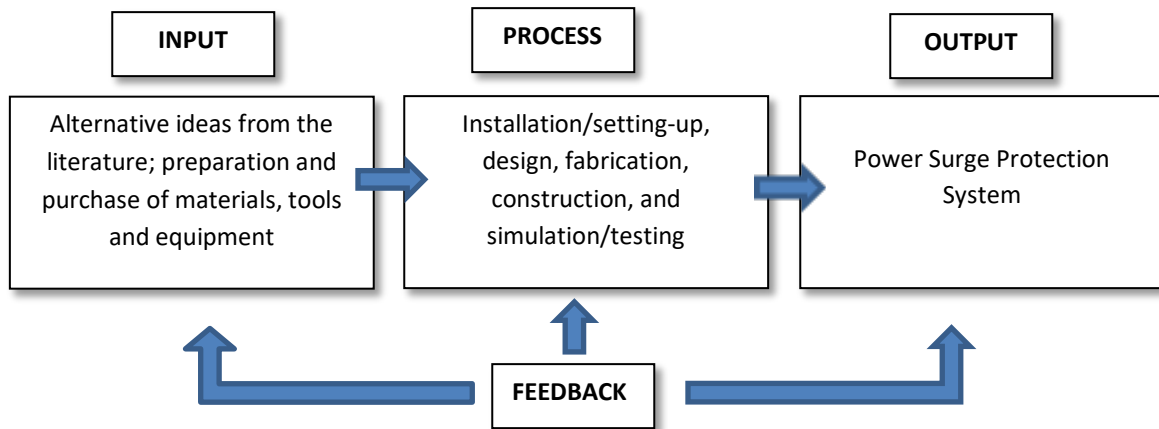


Figure 1. The Conceptual Framework

The conceptual framework can be presented using concepts, facts, variables and their relations that explain or predict how an observed phenomenon exists and operate as graphically shown below.

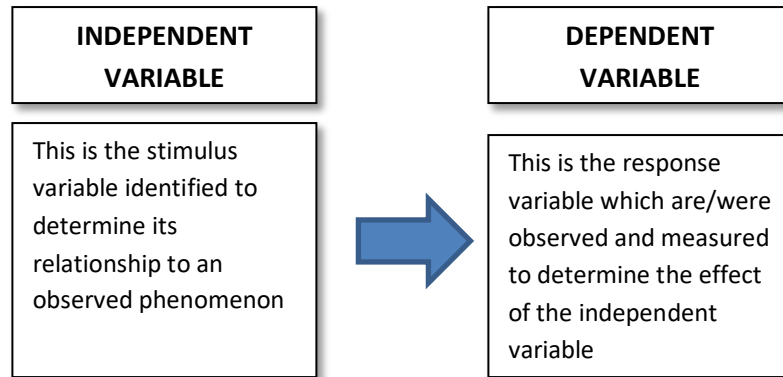


Figure 2. The Conceptual Framework

2 double spacing, 12 font size, justified

### SYNTHESIS

This contains summary of the review of past studies that are relevant to the present conduct of the study. It is worth mentioning the methods, procedures, and framework adopted from the literature, and it contains relevant information with a strong connection or relevance to the study taken from the past studies.

2 double spacing, 12 font size, justified

### DEFINITION OF TERMS

This is to enumerate the key terms used in the study and it is recommended to use the “operational term” in defining these key terms. It is operational term when it is based on an observed characteristic and how this term is used in the study.

**Bluetooth Emulator** – it enables Bluetooth communication from and to emulator.

**Pilferage** – the act of stealing electricity.

### **HYPOTHESIS OF THE STUDY (IF APPLICABLE)**

A hypothesis is formulated and temporarily adopted to explain the observed facts which guides in the conduct of the study, particularly on the kind of data or information to be collected.

This is normally used in experimental and descriptive researches. Some examples are as follows:

**Specific Problem 1:** *Is there a significant difference on the level of environmental awareness of the respondents across socio-economic and cultural variables?*

**Null Hypothesis:** *There is no significant difference on the level of environmental awareness of the respondents across socio-economic and cultural variables.*

**Specific Problem 2:** *Is there a correlation between socio-economic variables and level of environmental awareness among Mangyan Tagabukid high school students?*

**Null Hypothesis:** *There is no correlation between socio-economic variables and level of environmental awareness among Mangyan Tagabukid high school students.*

Top Margin: 1.5"

No page #

### CHAPTER III

2 double spacing, 12 font size,

Indent, 1 Tab, justified

Right Margin: 1"

#### RESEARCH METHODOLOGY

This chapter presents the methodology used in the study, including the materials and equipment or instruments used, selection of respondents and instruments (questionnaire, case study), and the overall procedures in the data collection and the statistical treatment of the data collected.

2 double spacing, 12 font size,

#### RESEARCH MATERIALS

Left Margin: 1.5"

This section covers the list of materials including the other components and formulations, and to be quantified. Technical specifications (if applicable) should be included with photos.

2 double spacing, 12 font size,

#### RESEARCH EQUIPMENT

There is a need to identify the equipment and major instruments/devices and apparatus used in the conduct of the study. Brief description is also helpful to identify these equipment, including technical specifications.

2 double spacing, 12 font size,

#### RESEARCH METHODS AND PROCEDURES

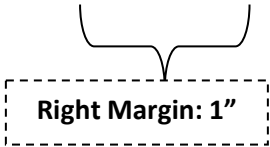
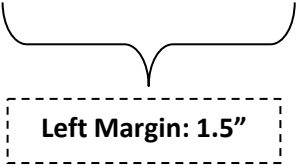
The section explains the comprehensive processes and stages in the preparation of the study. If applicable, flow chart and diagram must be presented to have a clearer understanding of the process and procedures. Adoption of testing procedures and standards should be clearly stated.

Bottom margin: 1"



**RESEARCH LOCALE AND TIME OF STUDY**

This section contains the area of the study. Briefly discuss the coverage of the study and its duration. A location map or vicinity map and other locational requirements will be presented in this section.



} Top margin: 1.5"

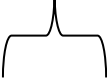
No page #

**CHAPTER IV**

} 2 double spacing, 12 font size, centered, justified

Indent, 1 Tab, justified

**RESULT AND DISCUSSION**



This chapter presents the methodology used in the study, including the materials and equipment or instruments used, selection of respondents and instruments (questionnaire, case study), and the overall procedures in the data collection and the statistical treatment of the data collected.

} 2 double spacing, 12 font size, centered, justified



Left Margin: 1.5"

**RESULT OF THE EXPERIMENT**

This section should be presented in such a way that it will answer the objectives of the study. Sub-headings will correspond to the objectives. Only relevant data from the experiments and statistical data will be presented in this section by tables and graphs. Less important data will be included as Appendices.

} 2 double spacing, 12 font size, centered, justified

**FINANCIAL ANALYSIS (IF APPLICABLE)**

This section provides a detailed computation (itemized) and financial discussion of the study particularly for studies that deals with design, development, and simulation of equipment and devices.

} Right Margin: 1"

} Bottom margin: 1"

Table 1. Tables and figures should be valuable, relevant, and visually attractive.

Heading	Heading	Heading	Heading
Component			
Component			
Total			

Tables (title is placed on top) and figures (title is placed at the bottom) should be carefully explained in the text and cited in numerical order. Use basic colors in the figures, charts, and diagrams.

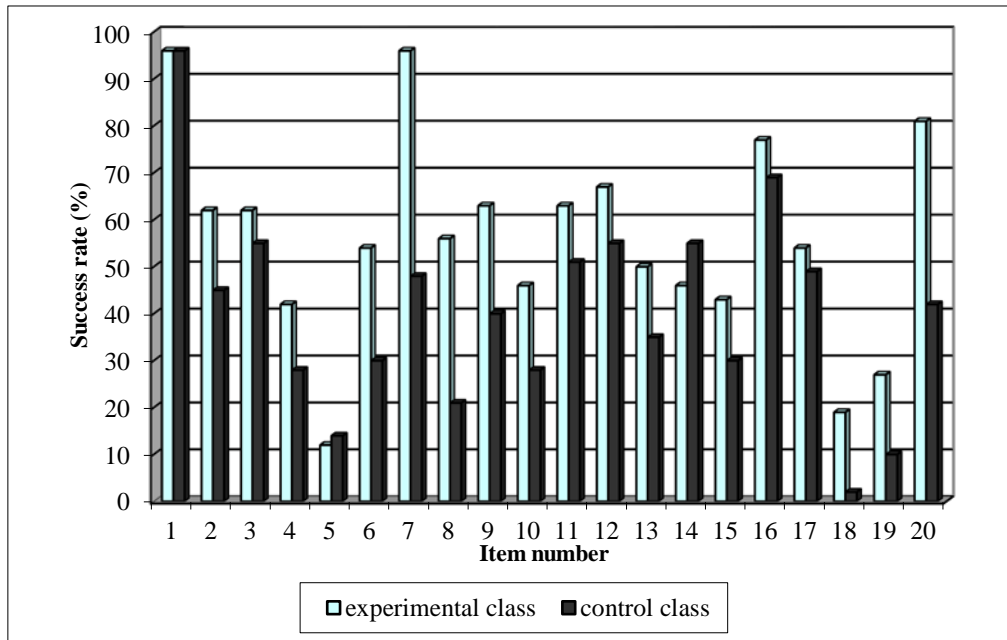


Figure 3: Comparison of success rate of items in the experimental and control class.

} Top margin: 1.5"

No page #

**CHAPTER V**

Indent, 1 Tab, justified

} 2 double spacing, 12 font size,

**SUMMARY, CONCLUSION AND RECOMMENDATION**

This chapter presents the important findings of the study. Findings should answer the research questions as stated in Chapter 1 or answering the research objectives. Please remember that summary, conclusion and recommendation must be consistent with each other.

} 2 double spacing, 12 font size,

} Right Margin: 1"

**SUMMARY**

} Left Margin: 1.5"

Left Margin: 1.5"

This section summarizes the results based on the objectives or research questions of the study. In other words, it will highlight the summary of findings which answers each of the objective or research question.

} 2 double spacing, 12 font size,

**CONCLUSION**

This section fits together with the summary. For example, if there are three (3) objectives with the summary findings, then there will also be three conclusions. This section also contains the acceptance and rejection of the hypotheses (if applicable).

} 2 double spacing, 12 font size,

**RECOMMENDATION**

This section is based on the summary and conclusion. It contains suggested activities for future undertakings or further research related to the study.

} Bottom margin: 1"



## REFERENCES

- Ramos, R. P. (2015). *Title of the Book*. City, Country: Publisher. (example citation from a book)
- Ramos, R. P. (2014). Title of the Article. *Name of the Journal*, Volume (Nos.), pages. (example citation of a journal)
- Ramos, R. P. (2016). *Research Methodology*. Retrieved from <http://www.bolender.com/action.htm> (example of citation from an online source)
- Castillo, F.S. (2007). *Research Education and Scientific Writing* (Latest Ed.). Manila, Philippines: Booklore Publishing Corporation (from a book with one author)
- Sha, A. S. (2011). *Research Methodology*. New Delhi, India: A P H Publishing Corporation (from a book with one author)
- Paler-Calmorin, L. & Calmorin M. A. (2007). *Research Methods and Thesis Writing*, (Second ed.). Manila, Philippines: Rex Printing Company, Inc. (from a book with two authors)
- Ramos, R. P. (2011). *Analysis of Mixed-use Schemes in Regeneration Areas*. Ph.D dissertation, Faculty of Art, Design and the Built Environment, University of Ulster (example of citation from PhD dissertation)
- Dela Vega, M., Gado, J. R., Galanga, C. M., Gaytano, G. F., Marcelo, E. S., Mayor, K. F., Mindoro, A. M., Morines, C. B., Motin, M. E., Overio, C S., & Teologo, R. G. (2016). *Bluetooth Application for Water Supply Control System*. Master thesis, College of Engineering and Technology, Romblon State University (example of citation from a Master's thesis)

Top margin: 1.5"

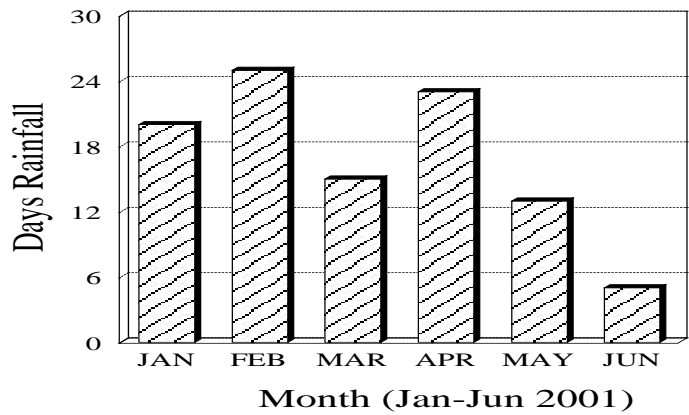


Figure 4: Clear line drawings are essential.

Bottom margin: 1"

Top margin: 1.5"

## APPENDICES

Left Margin: 1.5"

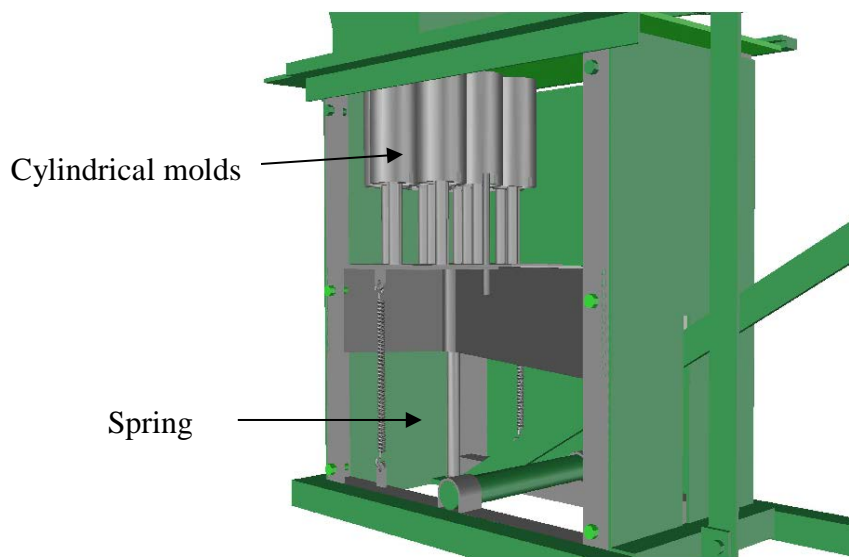
### APPENDIX A

Right Margin: 1"

## DOCUMENTATION

Include photographs, figures, tables, diagrams, charts, test results, standard procedures, programming, plans and drawings, tabulations, computations, transmittal letters, statistical print-outs, survey forms, with proper captions or titles. It should be mentioned in the main report for easy cross-reference.

Double spacing, 12 font size,



The Briquetting chamber

## BIOGRAPHICAL SKETCH

This includes a brief profile of the student researchers with clear 2x2 photo size, with signature specimen of the student.

Bottom margin: 1"

## CERTIFICATE OF ENGLISH CRITIC

A certification from an English teacher that the report is properly checked to meet University's technical writing standards.

### SIDE OF THE BINDED THESIS (RED COLOR)

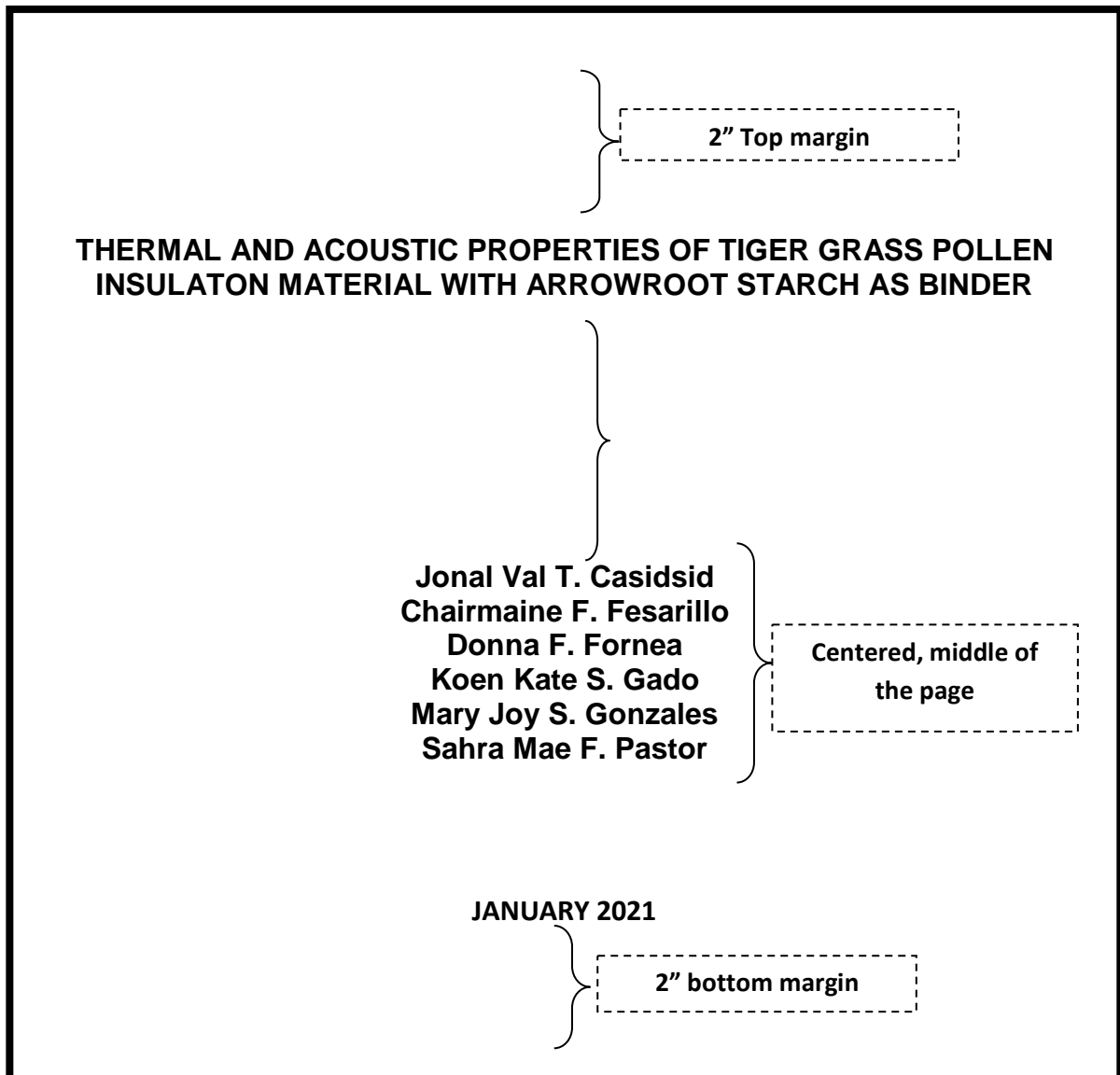
---

THESIS    BACHELOR OF SCIENCE IN CIVIL ENGINEERING    CASIDSID, M. ET AL.    JANUARY 2021

---

### FRONT COVER OF THE BINDED THESIS (RED COLOR)

---



**ADDITIONAL REFERENCE MATERIALS**

## APA Referencing (6<sup>th</sup> edition)

This is the Wintec guide to help you with referencing in the American Psychological Association (APA) style. For further information, please refer to the 6th edition of *The Publication Manual of the American Psychological Association* (2010), or see a staff member in the Library, Student Learning Services or Te Kete Kōnae.

### Referencing: what it is and why we do it

When writing an assignment, you will read various books, articles and websites to find information. You **must** acknowledge the ideas you get from these sources, to

- avoid [Plagiarism](#)
- credit the author from whom you got an idea
- allow others to read the same resources
- back up your ideas with authoritative work by another author
- show you have looked at a variety of resources

Referencing consists of two parts:

- Full entry in the [Reference list](#)
- AND
- [In-text citation](#) within your assignment.

Further resources on referencing using APA are available on the Referencing page of the Academic Learning Resources on Moodle: <https://learning.wintec.ac.nz/course/view.php?id=3037&section=6>

### Examples of how to reference different types of resources

<a href="#">Audio-visual media</a>	<a href="#">DVD/film</a> , <a href="#">Music recording</a> , <a href="#">Podcast</a> , <a href="#">Television series</a> , <a href="#">YouTube clip</a> ,
<a href="#">Books</a>	<a href="#">No author</a> , <a href="#">One author</a> , <a href="#">Two authors</a> , <a href="#">3-5 Authors</a> , <a href="#">Six Authors/Editors</a> , <a href="#">Chapter</a> ,
<a href="#">Journals &amp; Serials</a>	<a href="#">Articles</a> , <a href="#">Articles with doi</a> , <a href="#">Articles from library database</a> , <a href="#">Articles from internet</a>
<a href="#">Online books and resources</a>	<a href="#">Webpages</a> , <a href="#">Conference papers</a> , <a href="#">Dictionary definitions</a> , <a href="#">Encyclopedias</a> , <a href="#">Blogs</a> ,
<a href="#">Other media</a>	<a href="#">Personal communication</a>
<a href="#">Other written resources</a>	<a href="#">Brochures</a> , <a href="#">Newspapers</a> , <a href="#">Course hand-outs</a> , <a href="#">lecture notes</a>

Reference list	In-text citation
<b>BOOKS</b>	
<b>Book with no author (including dictionaries – see <a href="#">APA FAQs</a>, pg. 3, “How do I reference a resource that lists no author?”)</b>	
<i>The complete encyclopaedia of garden flowers.</i> (2003). Auckland, New Zealand: Bateman.	<i>The Complete Encyclopaedia of Garden Flowers</i> (2003) shows that ... (p. 96).
<b>Book with one author</b>	
Jones, R. (2007). <i>Nursing leadership and management: Theories, process and practice.</i> Philadelphia, PA: F. A. Davis.	Jones (2007) notes that ... (p. 184). <i>Or</i> ... (Jones, 2007, p. 184).
<b>Book with two authors</b>	
Claiborne, L., & Drewery, W. (2010). <i>Human development: Family, place, culture.</i> North Ryde, Australia: McGraw-Hill.	Claiborne and Drewery (2010) state that.... (p. 88). <i>Or</i> ... (Claiborne & Drewery, 2010, p. 88).
<b>Book with three to five authors</b>	
Hubbard, J., Thomas, C., & Varnham, S. (2010). <i>Principles of law for New Zealand business students</i> (4 <sup>th</sup> ed.). Auckland, New Zealand: Pearson.	<b>First citation</b> - Hubbard, Thomas and Varnham (2010) state that... (p. 4) <i>Or</i> ... (Hubbard, Thomas, & Varnham, 2010, p. 4). <b>Then</b> – Hubbard et al. (2010) report that ... (p. 4). or ... (Hubbard et al., 2010, p. 4).
<b>Book with six or more authors / editors (<a href="#">see also Journal article with six or more authors</a>)</b>	
Mezey, M. D., Cassel, C. K., Bottrell, M. M., Hyer, K., Howe, J. L., & Fulmer, T. T. (Eds.). (2002). <i>Ethical patient care: A casebook for geriatric health care teams.</i> Baltimore, MD: Johns Hopkins University Press.	First citation – Mezey et al. (2002) explain that ... (p. 58). <i>Or</i> ... (Mezey et al., 2002, p. 58).
<b>Book or report by a corporate author</b> (e.g. an organisation, association or Government Department)	
University of Otago. (1986). <i>Today's food, tomorrow's health.</i> Dunedin, New Zealand: Author.	The University of Otago (1986) claims that .... (p. 6). <i>Or</i> ... (University of Otago, 1986, p. 6).
<b>Book chapter in an edited work</b>	
Hales, M. (2012). Community health nursing. In A. Berman, S. Snyder, T. Levett-Jones, T. Dwyer, M. Hales, N. Harvey, ...D. Stanley (Eds.), <i>Kozier and Erb's fundamentals of nursing</i> (2 <sup>nd</sup> Australian ed., Vol. 1, pp. 127-141). Frenchs Forest, Australia: Pearson.	Hales (2012) reports that... (p. 129). <i>Or</i> ... (Hales, 2012, p. 129).
<b>ONLINE BOOKS AND RESOURCES</b>	
<b>NB A Digital Object Identifier (doi) is a unique ‘number’ (or code) to identify content and provide a reliable link to its location on the Internet. Unlike a URL, a doi never changes.</b>	
<b>Book with a digital object identifier (doi)</b>	
Kay, G. N. (1999). <i>Fiber optics in architectural lighting: Methods, design, and applications.</i> doi:10.1036/0070349320	Kay (1999) notes ... (p. 65). <i>Or</i> ... (Kay, 1999, p. 65).
<b>Book with no doi retrieved from an online database (see <a href="#">APA FAQs</a> for more information)</b>	
Fox, W. (2006). <i>Theory of general ethics: Human relationships, nature, and the built environment.</i> Retrieved from ebrary database.	Fox (2006) states ... (p. 53). <i>Or</i> ... (Fox, 2006, p. 53).
OR:	

<p>Gulanick, M., &amp; Myers, J. L. (2014). <i>Nursing care plans: Diagnoses, interventions, and outcomes</i> (8<sup>th</sup> ed.). Retrieved from EBL database.</p> <p><b>NB</b> Also see <a href="#">APA FAQs</a> – questions under <b>Ebooks</b>.</p>	<p>Gulanick and Myers (2014) note... (p. 91 )  <i>Or</i> ... (Gulanick and Myers, 2014, p. 91).</p>
<p><b>Dictionary definitions - no author or editor</b></p>	
<p>Practice. (n.d.). In <i>Merriam-Webster's online dictionary</i>. Retrieved from <a href="http://www.merriam-webster.com/dictionary/practice">http://www.merriam-webster.com/dictionary/practice</a></p>	<p>(Practice, n.d.)</p>
<p><b>Dictionary definitions - author or editor</b></p>	
<p>Simpson, J. (Ed.). (2012). Practice. In <i>Oxford English dictionary</i>. Retrieved from <a href="http://www.oed.com/view/Entry/149226">http://www.oed.com/view/Entry/149226</a></p> <p><b>NB</b> For print dictionary include the publication details instead of “retrieved from URL”</p>	<p>(Simpson, 2012)</p>
<p><b>Online encyclopedias – author or editor</b></p>	
<p>Easton, B. (2012). Economic history: Boom and bust, 1870-1895. In <i>Te Ara: The encyclopedia of New Zealand</i>. Retrieved April 15, 2015 from <a href="http://www.teara.govt.nz/en/economic-history/page-5">http://www.teara.govt.nz/en/economic-history/page-5</a></p> <p><b>NB</b> Only include retrieval dates, if, at the bottom of the page, it says it has been updated on a particular date.</p>	<p>“Atkinson’s careful management of the national finances set the economy up for the long boom, which began in the mid-1890s” (Easton, 2012, “Bust”, para. 4).</p>
<p><b>Blog post</b></p>	
<p>vaughanbell. (2010, November 1). It only exists if I see colours on the brain scan [Blog post]. Retrieved from <a href="http://mindhacks.com/2010/11/01/it-only-exists-if-i-can-see-colours-on-a-brain-scan/">http://mindhacks.com/2010/11/01/it-only-exists-if-i-can-see-colours-on-a-brain-scan/</a></p> <p><b>NB</b> If the author’s name is in lowercase, it should remain so in the reference list. This title is not italicised.</p>	<p>vaughanbell (2010) argues that... (para. 3).  <i>Or</i> ... (vaughanbell, 2010, para. 3).</p>
<p><b>Webpage</b></p>	
<p>Statistics New Zealand. (2014). <i>New Zealand in profile 2014</i>. Retrieved from <a href="http://www.stats.govt.nz">http://www.stats.govt.nz</a></p>	<p>Statistics New Zealand (2014) provides evidence for ... (para. 2).  <i>Or</i> ... (Statistics New Zealand, 2014, para. 2).</p>
<p><b>Webpage (no date)</b></p>	
<p>Department of Conservation. (n.d.). <i>New Zealand’s marine environment</i>. Retrieved June 17, 2014 from <a href="http://www.doc.govt.nz/conservation/marine-and-coastal/new-zealands-marine-environment/">http://www.doc.govt.nz/conservation/marine-and-coastal/new-zealands-marine-environment/</a></p> <p><b>NB</b> Only include retrieval dates where information on the website may change over time.</p>	<p>The Department of Conservation (n.d.) estimates that ... (para. 4).  <i>Or</i> ... (Department of Conservation, n.d., para. 4).</p>
<p><b>Conference paper in published proceedings online</b></p>	
<p>Flintoff, V., &amp; Flanagan, P. (2010, April). The ‘ménage à trois’ complexity of external supervision. In L. Beddoe &amp; A. Davies (Eds.), <i>Common threads, different patterns: Supervision Conference 2010, Auckland, New Zealand: Proceedings</i>, (pp. 8-17). Retrieved from <a href="https://cdn.auckland.ac.nz/assets/education/about/schools/chss/wk/docs/2010-Supervision-Conference-Proceedings.pdf">https://cdn.auckland.ac.nz/assets/education/about/schools/chss/wk/docs/2010-Supervision-Conference-Proceedings.pdf</a></p>	<p>Flintoff and Flanagan (2010) mention ... (p. 9).  <i>Or</i> ... (Flintoff &amp; Flanagan, 2010, p. 9).</p>



## JOURNALS

**NB Retrieval Statements:** There are 2 types of retrieval statements used when there is no **doi** available. The date is only included if the source material is likely to change over time.

1. Retrieved from (name of the database)
2. Retrieved from <http://www...>

### Journal or serial article (print version)

Millard, S. K., Nicholas, A., & Cook, F. M. (2008). Is parent-child interaction effective in reducing suffering? *Journal of Speech, Language & Hearing Research*, 51(3), 636-650.

**First citation** – Millard, Nicholas and Cook (2008) explain .... (p. 640).  
**Or** ... (Millard, Nicholas, & Cook, 2008, p. 640).  
**Then** – Millard et al. (2008) explain ... (p. 640).  
**Or** ... (Millard et al., 2008, p. 640).

### Journal or serial article with six or more authors ([See also Book with six authors/editors](#))

Gilbert, D. G., McClernon, J. F., Rabinovich, N. E., Sugai, C., Plath, L. C., Asgaard, G., ... Botros, N. (2004). Effects of quitting smoking on EEG activation and attention last for more than 31 days and are more severe with stress, dependence, DRD2 A1 allele, and depressive traits. *Nicotine and Tobacco Research*, 6, 249-267. doi:10.1080/1462220041001676305

First citation – Gilbert et al. (2004) indicate that .... (p. 252).  
**Or** ... (Gilbert et al., 2004, p. 252).

### Journal or serial article with a doi

Stulz, J. (2006). Integrating exposure therapy and analytic therapy in trauma treatment. *American Journal of Orthopsychiatry*, 76(4), 482-488. <http://dx.doi.org/10.1037/0002-9432.76.4.482>

Stulz (2006) discusses ... (p. 486).  
**Or** ... (Stulz, 2006, p. 486).

### Journal or serial article from a library database

Bumpus, M. A., & Burton, G. (2008). Chapters in the life of an entrepreneur: A case study. *Journal of Education for Business*, 83(5), 302-308. Retrieved from ABI Inform database.

**NB Undergraduates:** Give the name of the database.

**Researchers:** Give the URL of the **journal** homepage. e.g. Retrieved from <http://www.tandfonline.com/toc/vjeb20/current>

Bumpus and Burton (2008) believe that ... (p. 303).  
**Or** ... (Bumpus & Burton, 2008, p. 303).

### Journal or serial article from the Internet

Pantaleo, S. (2005). 'Reading' young children's visual texts. *Early Childhood Research & Practice*, 7(1). Retrieved from <http://ecrp.uiuc.edu/v7n1/pantaleo.html>

**NB In-text citation notes the section title on an online document without page numbers.**

Pantaleo (2005, Classroom context) states .... (para. 3).  
**Or** ... (Pantaleo, 2005, Classroom context, para. 3).

## OTHER WRITTEN RESOURCES

### Brochure or pamphlet

YouthLaw: Tino Rangatiratanga Taitamariki. (2003). *Free legal service for children and young people* [Brochure]. Tamaki Makaurau, New Zealand: Author.

YouthLaw: Tino Rangatiratanga Taitamariki (2003) identifies ...  
**Or** ... (YouthLaw: Tino Rangatiratanga Taitamariki, 2003).

### Newspaper article (no author, print version)

Kiwi speller at home among international bright sparks. (2008, May 20), *New Zealand Herald*, p. A11.

... ("Kiwi Speller," 2008, p. A11).

<b>Newspaper article from the Internet</b>	
Tait, M. (2014, June 12). Rubbish trial is food for thought. <i>New Zealand Herald</i> . Retrieved from <a href="http://www.nzherald.co.nz">http://www.nzherald.co.nz</a>	Tait (2014) indicates ... (para. 4). <i>Or</i> ... (Tait, 2014, para. 4).
<b>NB Give the URL of the newspaper home page to avoid broken links.</b>	
<b>Newspaper article from a database</b>	
Flowers, M. (2014, May 13). Growth-driving polytechs hurt by dated public image. <i>New Zealand Herald</i> . Retrieved from Newztext Plus database.	Flowers (2014) notes ... (para. 4). <i>Or</i> ... (Flowers, 2014, para. 4).
<b>Course hand out / Lecture notes</b>	
Smith, A. (2014, May 12). <i>A model of nursing care</i> [PowerPoint slides]. Hamilton, New Zealand: Wintec.	...as Smith (2014) found.... <i>Or</i> ... (Smith, 2014).
<b>AUDIO VISUAL MEDIA</b>	
<b>Television series (single episode)</b>	
McGovern, J. (Writer), & Fywell, T. (Director). (1994). To be a somebody [Television series episode]. In S. Hood (Executive producer), <i>Cracker</i> . Manchester, England: Granada.	McGovern (1994) shows ... <i>Or</i> ... (McGovern, 1994).
<b>DVD / Film</b>	
Campion, J. (Director), & Chapman, J. (Producer). (1993). <i>The piano</i> [DVD]. Australia: Australian Film Commission.	Campion and Chapman (1993) note ... <i>Or</i> ... (Campion & Chapman, 1993).
<b>Music recording</b>	
Waters, R. (1973). Money [Recorded by Pink Floyd]. On <i>The dark side of the moon</i> [CD]. Middlesex, England: Harvest.	...“Money” (Waters, 1973, track 6). <i>Or</i> ... “Money” (Waters, 1973, track 6)...
<b>YouTube Video</b>	
Apsolon, M. [markapsolon]. (2011, September 9). <i>Real ghost girl caught on Video Tape 14</i> [Video file]. Retrieved from <a href="http://www.youtube.com/watch?v=6nyGCbxD848">http://www.youtube.com/watch?v=6nyGCbxD848</a>	Apsolon (2011) shows.... <i>Or</i> ... (Apsolon, 2011).
<b>NB Include both the full name and the username if possible, as formatted above. Otherwise, put the author’s screen name first, as formatted above; no brackets.</b>	
<b>Podcasts</b>	
Bushnell, P. (Producer). (2014, January 5). <i>You call this art?: Part 1</i> [Audio podcast]. Retrieved from <a href="http://www.radionz.co.nz">http://www.radionz.co.nz</a>	Bushnell (2014) comments.... <i>Or</i> ... (Bushnell, 2014).
<b>OTHER MEDIA</b>	
<b>Personal communication</b>	
As this material is not recoverable or archived, it is <b>not</b> included in a reference list, but is acknowledged <b>in-text</b> . Include private letters, tutor comments, own class notes, interviews, telephone conversations, etc. Use the initials and surname of the person and as exact a date as possible.	K. W. Wiremu (personal communication, January 18, 2010) commented that...

## FOR MORE INFORMATION OR ASSISTANCE, PLEASE CONTACT A STAFF MEMBER FROM:

The Library **OR** Student Learning Services **OR** Te Kete Kōnae

### Reference Lists

At the end of your assignment, you are required to provide full reference information for **each source** you have used. Reference lists give full information about the printed and electronic sources referred to in your writing so that your reader is able to locate the sources you used.

#### The items in your reference list need to be:

- In alphabetical order, by the author/producer's surname, in the order they appear on the title page
- Combined in one list - do not separate different types of sources
- In correct format (brackets, punctuation, capital letters, italics, etc.) as in the examples in this guide. This includes underlining all URLs so they are active hyperlinks.
- In 'hanging indent' format
- Checked with your department for their preferred line spacing

#### Remember, be consistent!

### In-Text Citation

In-text citations include the author's name, publication date of the item and the page or paragraph showing where you found the information.

**Direct Quotation** – You can quote part or all of an author's sentence; select the part that is most useful for your purpose.

You copy the words **exactly** from the source, using double quotation marks to show which words are copied. Show the surname of the author(s), the year of publication and page (or paragraph) number, in brackets, e.g.

1. MacFarlane (2004) notes that allowing "time to bond with students is the first step in classroom management" (p. 90).
2. "Taking time to bond with students is the first step in classroom management" (MacFarlane, 2004, p. 90).

**NB** A reference at the end of a sentence is part of that sentence so put a full stop after the final bracket.

**Paraphrasing** – Paraphrasing is more than changing a few words; you need to use your own sentence structure and phrases. You put the author's meaning into your own words so there is no need for double quotation marks, e.g.

1. MacFarlane (2004) indicates that smoother organisation of a classroom is possible when teachers take the time to connect with their class (p. 90), although this is not always the case.
2. True classroom control can start when a teacher connects with the students (MacFarlane, 2004, p. 90).

**NB** The page number should be provided at the end of the paraphrase, whether or not it is at the end of the sentence. This will ensure that you have identified the author/owner of the idea you are using.

For more information on paraphrasing, see [Paraphrasing video](#)

**Edited books** - When using material by the author(s) of a chapter in an edited book use only the chapter author's name in-text and the year of publication of the book. (See example: [Book chapter in an edited work](#))

**Citations from a secondary source** - put the surname of the person you are quoting, followed by 'as cited in', then the surname, year and page of the book or article you read it in, e.g.

1. Sullivan and Decker (as cited in Jones, 2007) discuss the importance of participation (p. 43).
2. The importance of participation cannot be over-estimated (Sullivan & Decker, as cited in Jones, 2007, p. 43).

**NB** Only the work cited is listed in the references; in this case, the details of the book by Jones.

**Connecting words** - Select an appropriate word to connect from author to in-text citation, e.g., states, reported, notes, found, suggests, mentioned, indicates, recognised, identified, argued, etc. This may occur at the beginning of a sentence, in the middle or at the end.

### Additional points about in-text citation

- **Omitting material:**  
Use 3 dots within a quote to indicate that you have omitted material from the original source, e.g.  
"This is the movement of the middle class ... from schools serving low socio-economic status (SES) areas to schools serving middle SES areas" (Brett, 1994, p. 43).
- **Adding emphasis:**  
To emphasise a word or words in a quotation use italic type, immediately followed by [emphasis added], e.g.  
Paraphrasing is more than "changing the order of a few words and substituting synonyms for a few others.  
Paraphrased ideas ... should *blend* [emphasis added] with your style" (Roundtree, 1991, p. 76) and show you understand the concept.
- **Inserting material:**  
Enclose your own additions to quotations, or explanations, in square brackets, e.g. Through play the child needs to learn to manipulate and master body, mind, emotions and relationships, as "such mastery is essential to [more extensive] cognitive development, strong ego development and good mental health" (Schuster & Ashburn, 1992, p. 328).
- **If a quote is longer than 40 words:** miss a line, do not change the line spacing, indent left and right, do not use quotation marks, put a full-stop **before** the in-text citation, and leave a line at the end. See example in [APA FAQs](#).
- **Incorporate quotations into your discussion:** They may be all or part of a sentence placed: at the beginning, embedded in, or at the end, of your sentence.
- **When quotations are complete sentences:** They need to be referred to in, or linked to, the previous and/or following sentence. This will show your understanding of the quote.

### Plagiarism

Plagiarism means using someone else's ideas or words in your assignment and presenting them as your own. This is not allowed, and is seen as academic theft. Work can be plagiarised from books, journal articles, websites, course notes, or the assignments of other students.

Although plagiarism can be **intentional** (when you deliberately copy work), it is often **unintentional**; this is usually because referencing is badly done or not done at all. When reading for an assignment, always write down author, title and publishing details of a work when you take notes from it so you can acknowledge the ideas in your assignment. This must be done both in text, and in the reference list.

Further resources:

- [Plagiarism and student responsibility](#)
- [Plagiarism video](#)



Romblon State University  
**COLLEGE OF ENGINEERING AND TECHNOLOGY**  
Odiongan, Romblon  
*Tel.no. (042) 567-5588*

**COMPILATION OF UNDEGRDUATE THESES**  
**(As of August 2020)**

<b>Control No.</b>	<b>CIVIL ENGINEERING Title</b>	<b>Date Submitted</b>
<b>RSU-CE-092</b>	Assessment of National and Provincial Road Condition in the Municipality of Odiongan	Ongoing Revision
<b>RSU-CE-091</b>	Design Study for a Village Coconut Processing Plant Located at Sta. Maria, Romblon	Ongoing Revision
<b>RSU-CE-090</b>	Proposed Site Development Plan for Romblon State University in Agpudlos, San Andres	Ongoing Revision
<b>RSU-CE-089</b>	Use of Waste Chicken Feather as Reinforcement in Cement-Bonded Composites with Peanut Shell as Additive	Ongoing Revision
<b>RSU-CE-088</b>	Profiling of the Taboboan River	Ongoing Revision
<b>RSU-CE-087</b>	Proposed Plan of Water System Distribution in Barangay Pangulo, Municipality of Calatrava	Ongoing Revision
<b>RSU-CE-086</b>	Design of Drainage System of San Andres, Romblon	Ongoing Revision
<b>RSU-CE-085</b>	Juice Drink Doypack as an Alternative Slope Protection	Ongoing Revision
<b>RSU-CE-084</b>	Treated Pulverized Seashells as Strength Accelerating Admixture for Concrete Pavement	Ongoing Revision
<b>RSU-CE-083</b>	Study of Waste Glass Powder and Marble Dust Mixture as Partial Replacement of Cement on Concrete	Ongoing Revision
<b>RSU-CE-082</b>	Optimizing the Levels of Cement, Marble Dust and Carbonized Rice Hull for Concrete	Ongoing Revision
<b>RSU-CE-081</b>	Development of Bamboo Laminated Plyboard for Student Desks	Ongoing Revision
<b>RSU-CE-080</b>	Profiling of Poctoy and Dapawan Rivers in Determining Flood Prone Areas	Ongoing Revision
<b>RSU-CE-079</b>	Physical and Mechanical Properties of Drywall Made from Paper Waste Using Cassava Starch as Binder	Ongoing Revision
<b>RSU-CE078</b>	Banana Leaf Ash as Partial Replacement for Cement in Concrete	Ongoing Revision
<b>RSU-CE-077</b>	Design, Develop and for Test of a Modified Vertical Helophytes System for the Romblon State University – College of Engineering and Technology Building	Ongoing Revision



Romblon State University  
**COLLEGE OF ENGINEERING AND TECHNOLOGY**  
Odiongan, Romblon  
*Tel.no. (042) 567-5588*

<b>RSU-CE-076</b>	Design study of Flood Control System of the Romblon State University- Main Campus	April 2019
<b>RSU-CE-075</b>	Initial Environmental Examination of the Road Network in Romblon State University – Agpudlos Development Project	April 2019
<b>RSU-CE-074</b>	Compressive Strength of concrete using fine aggregates from selected quarry sites in Odiongan, Romblon	April 2019
<b>RSU-CE-073</b>	Effect of Marble Nanoparticles as Additive on the Physical and Mechanical properties of Concrete Mixes	April 2019
<b>RSU-CE-072</b>	Determination of Mechanical and Physical properties of Marbles in the Province of Romblon	April 2019
<b>RSU-CE-071</b>	Design study for Proposed Access Road, Main gate and Academic Oval of Romblon State University	April 2019
<b>RSU-CE-070</b>	Proposed Design of a Water Supply System in Barangay Balogo, Calatrava Romblon	April 2019
<b>RSU-CE-069</b>	Shear and Tensile Properties of Kawayan Tinik ( <i>Bambusa blumeana</i> , Schult. and Schult.f.) and Patong ( <i>Dendrocalamus latiflorus</i> , Munro)	April 2019
<b>RSU-CE-068</b>	Assessment And Evaluation Of Existing Drainage System Of The Town Proper Of Municipality Of Odiongan, Romblon	April 2018
<b>RSU-CE-067</b>	The Effects Of Particle Size Coarse Aggregates On The Compressive Strength Of Concrete From Selected Quarry Sites In Tablas Island, Romblon	April 2018
<b>RSU-CE-066</b>	Design Of Rainwater Harvesting System Of The 2-Storey Academic Building For The College Of Engineering And Technology, Romblon State University (Main Campus)	April 2018
<b>RSU-CE-065</b>	Improvement Of The Existing Water System In Bagsik, Alcantara, Romblon	May 2017
<b>RSU-CE-064</b>	Proposed RSU Sports Arena	May 2017
<b>RSU-CE-063</b>	Proposed Improvement Of Budiong-Bangon Road, Odiongan, Romblon	April 2017
<b>RSU-CE-062</b>	Proposed 3-Storey College Of Engineering And Technology Building Romblon State University Main Campus	April 2017
<b>RSU-CE-061</b>	Design And Analysis Of Water Supply System Of RSU- Agpudlos Campus, San Andres, Romblon	April 2017



Romblon State University  
**COLLEGE OF ENGINEERING AND TECHNOLOGY**  
Odiongan, Romblon  
*Tel.no. (042) 567-5588*

<b>RSU-CE-060</b>	Thermal And Acoustic Properties Of Tiger Grass Pollen Insulation Material With Arrowroot Starch As Binder	February 2017
<b>RSU-CE-059</b>	Comprehensive Land Use Plan Of Romblon State University Main Campus	August 2016
<b>RSU-CE-058</b>	Profiling Of Bangon River System In The Municipality Of Odiongan	August 2016
<b>RSU-CE-057</b>	Development Of Timber Truss Analysis Software Application	August 2016
<b>RSU-CE-056</b>	Cost Estimate Project Management And Structural Design Analysis Of The Proposed Facilities For Romblon State University Agpudlos Campus, San Andres, Romblon	June 2016
<b>RSU-CE-055</b>	Compressive Strength Of Concrete Reinforced With Banana Fibers	January 2015
<b>RSU-CE-054</b>	Styrofoam Dissolved In Gasoline As An Adhesive For Particle Board	January 2015
<b>RSU-CE-053</b>	Assessment Of Indoor Air Quality In Romblon State University Main Campus Building	January 2015
<b>RSU-CE-052</b>	Proposed Improvement Of Romblon State University Irrigation Water Distribution System	January 2015
<b>RSU-CE-051</b>	Proposed RSU Eco-Park	March 2015
<b>RSU-CE-050</b>	Sound Absorption Characteristic Of Coconut Husk Acoustic Panel Using Different Types Of Binders	March 2015
<b>RSU-CE-049</b>	Compressive Strength Of Concrete Using Tiger Grass As Fiber Reinforcement	March 2015
<b>RSU-CE-048</b>	Factors Affecting The Compressive Strength Of Concrete Using Aggregates From Selected Quarry Sites In Odiongan, Romblon	March 2015
<b>RSU-CE-047</b>	Proposed Solid Waste Management Plan Of Romblon State University, Main Campus	March 2015
<b>RSU-CE-046</b>	Evaluation And Improvement Plan Of Existing Water System Of Cawayan-Long Beach, San Agustin, Romblon	March 2014
<b>RSU-CE-045</b>	Modified Interlocking Precast Concrete Blocks For Fence Wall: Prototype	March 2014
<b>RSU-CE-044</b>	Compressive Strength Of Concrete Using Aggregates From Different Quarry Sites In Odiongan, Romblon	March 2014



Romblon State University  
**COLLEGE OF ENGINEERING AND TECHNOLOGY**  
 Odiongan, Romblon  
*Tel.no. (042) 567-5588*

<b>RSU-CE- 043</b>	Comparative Analysis Of Concrete's Compressive Strenth Using Ilang-Ilang ( <i>Cananga Odorata</i> ), Paper Tree ( <i>Gmelina Haenanensis</i> ) And Coconut ( <i>Cocus Nucifera</i> ) Sawdust As A Full Replacement For Sand	March 2014
<b>RSU-CE-042</b>	Plastic Waste Material As Partial Substitute For Sand In Concrete Bricks	March 2014
<b>RSU- CE-041</b>	Design And Development Of Portable Concrete Mixer	March 2013
<b>RSU-CE-040</b>	Designed Household Waste Water Treatment Facility Model : Modified	March 2013
<b>RSU-CE-039</b>	Design And Fabrication Of Mechanical Sieve Machine	March 2013
<b>RSU-CE-038</b>	Design And Development Of Mechanical Brick Molding Machine	March 2013
<b>RSU-CE-037</b>	Design Of Wastewater Treatment Facilities In Odiongan Public Market, Odiongan, Romblon	April 2012
<b>RSU-CE-036</b>	NSCP 2001 And NSCP 2010: A Comparative Analysis	June 2012
<b>RSU-CE-035</b>	Household Wastewater Treatment Facility: A Proposed Model	April 2012
<b>RSU-CE-034</b>	Safety First: An Assessment Of Health And Safety Culture Among Construction Workers In The Province Of Romblon	April 2012
<b>RSU-CE-033</b>	Proposed Development Of Existing Drainage System Of Selected Flooded Areas In Barangay Poctoy And Barangay Dapawan, Odiongan Romblon	April 2012
<b>RSU-CE-032</b>	Design And Fabrication Of Mechanical Sieve Shaker	February 2012
<b>RSU-CE-031</b>	Road Safety Signs, Traffic Laws, Rules And Regulations: Degree Of Awareness Of Permitted And Licensed Drivers As Of 2011 In The Municipality Of Odiongan	April 2012
<b>RSU-CE-030</b>	Construction Of The Romblon Provincial Hospital Main Building: A Proposal	May 2011
<b>RSU-CE-029</b>	Proposed Construction Of Additional Water Supply System At Rizal, Odiongan, Romblon	May 2011
<b>RSU-CE028</b>	Proposed Improvement Of Odiongan South Central Elementary School Existing Drainage System	May 2011





Romblon State University  
**COLLEGE OF ENGINEERING AND TECHNOLOGY**  
Odiongan, Romblon  
*Tel.no. (042) 567-5588*

<b>RSU-CE-027</b>	Secret Paradise: A Proposed Resort At San Jose (Carabao Island), Romblon	May 2011
<b>RSU-CE-026</b>	Proposed Design And Construction Of Bridge In Sitio Bulwang, Gabawan, Odiongan, Romblon	August 2011
<b>RSU-CE-025</b>	Proposed Development And Upgrading Of Romblon State University Existing Drainage System	February 2010
<b>RSU-CE-024</b>	Proposed Four-Storey Kad-Bayan MPC Commercial Building	March 2010
<b>RSU-CE-023</b>	Proposed Memorial Park In The Municipality Of Odiongan	April 2010
<b>RSU-CE-022</b>	Proposed Expansion Of Looc Water Supply System	April 2010
<b>RSU-CE-021</b>	Proposed Reclamation And Development Of Odiongan Bay Walk	March 2010
<b>RSU-CE-020</b>	Proposed Low-Cost Housing Project In The Municipality Of Odiongan	April 2009
<b>RSU-CE-019</b>	Proposed Construction Of A Three- Storey Hotel	April 2009
<b>RSU-CE-018</b>	Proposed Design And Construction Of New Odiongan Slaughterhouse	April 2009
<b>RSU-CE-017</b>	Proposed Construction Of Three Storey Odiongan Commercial Center	March 2008
<b>RSU-CE-016</b>	Proposed Construction Of Aquadome In Romblon State College Main Campus, Odiongan, Romblon	March 2008
<b>RSU-CE-015</b>	Proposed Construction Of Centennial Building	March 2008
<b>RSU-CE-014</b>	Proposed Construction Of Romblon State College Mini-Dam And Irrigation Structure	March 2007
<b>RSU-CE-013</b>	Proposed Romblon State College Main Campus Water Supply System (Level II)	March 2007
<b>RSU-CE-012</b>	Proposed Construction Of Low Cost Housing Sitio Colis Calunacon, San Andres, Romblon	April 2005
<b>RSU-CE-011</b>	The Proposed Relocation And Construction Of Looc Public Market	March 2004



Romblon State University  
**COLLEGE OF ENGINEERING AND TECHNOLOGY**  
 Odiongan, Romblon  
*Tel.no. (042) 567-5588*

<b>RSU-CE-010</b>	Proposed Upgrading And Improvement Of Odiongan Existing Drainage System	March 2004
<b>RSU-CE-009</b>	Proposed Construction Of Two-Storey Apartment Building With Water Purifying Station	March 2004
<b>RSU-CE-008</b>	Proposed Construction Of Beach Resort	March 2004
<b>RSU-CE-007</b>	Proposed Construction Of Memorial Garden( Divine Paradise Memorial Garden)	March 2003
<b>RSU-CE-006</b>	Proposed Construction Of Low-Cost Housing	March 2003
<b>RSU-CE-005</b>	Proposed Construction Of Two-Storey Commercial Building	March 2002
<b>RSU-CE-004</b>	Proposed Construction Of Two-Storey Apartment Building	March 2002
<b>RSU-CE-003</b>	Proposed Construction Of Two-Storey Fast Food Center Liwayway, Odiongan,Romblon	March 2002
<b>RSU-CE-002</b>	A Project Study On A Proposed Concreting Of A 1.060 Km. Campus Road, Rsc, Odiongan, Romblon	March 2001
<b>RSU-CE-001</b>	Proposed Construction Of Romblon State College Two-Storey Engineering Building	March 2001
<b>Control No.</b>	<b>MECHANICAL ENGINEERING Title</b>	<b>Date Submitted</b>
<b>RSU-ME-035</b>	Development and Evaluation of an Automated Fish Smokehouse Machine	April 2019
<b>RSU-ME-034</b>	Evaluation of the Effectiveness of different absorbents in Dehumidified Air Dryer	April 2019
<b>RSU-ME-033</b>	Design, Development And Testing Of Turnstile Energy Harvester	April 2018
<b>RSU-ME-032</b>	Design, Fabrication And Performance Test Of A Prototype Jackfruit Peeling And Slicing Machine	April 2018
<b>RSU-ME-031</b>	Design, Development And Testing Of Multi Root Crop Washing Machine	April 2018



Romblon State University  
**COLLEGE OF ENGINEERING AND TECHNOLOGY**  
Odiongan, Romblon  
*Tel.no. (042) 567-5588*

<b>RSU-ME-030</b>	Design Fabrication And Performance Evaluation Of Coin Slotted Automatic Shoe Polishing Machine	April 2017
<b>RSU-ME-029</b>	Development And Modification Of A Mechanical Mango Picker	April 2017
<b>RSU-ME-028</b>	Design And Fabrication Of A Prototype Steamed Rice Dehumidifier	April 2017
<b>RSU-ME-027</b>	Design, Development And Evaluation Of A Solar Powered Agricultural Sprayer	April 2017
<b>RSU-ME-026</b>	Design And Development Of Rice Straw Twining Machine	May 2016
<b>RSU-ME-025</b>	Development Of An Air-Conditioning Trainer Unit For Instructional Purposes	May 2016
<b>RSU-ME-024</b>	Development Of Refrigerator Trainer Unit For Instructional Purposes	May 2016
<b>RSU-ME-023</b>	Design, Fabrication And Performance Evaluation Of A Modified Manually Operated Rice Seeder	April 2015
<b>RSU-ME-022</b>	Design, And Fabrication Of Polyethylene Terephthalate (Pet) Bottle Shredder	May 2015
<b>RSU-ME-021</b>	Design And Development Of Prototype Charcoal Fired Bibingka Oven	March 2014
<b>RSU-ME-020</b>	Development And Test Of A Mechanical Whiteboard Eraser	March 2014
<b>RSU-ME-019</b>	Design And Fabrication Of Pelleting Machine	March 2014
<b>RSU-ME-018</b>	Design And Development Of A Water Pump Powered By Flowing Water	March 2014
<b>RSU-ME-017</b>	Design And Fabrication Of Combined Cassava Peeler And Cleaner Machine	April 2013
<b>RSU-ME-016</b>	Design And Development Of A Small Capacity Mungbean Shelling Machine	April 2013
<b>RSU-ME-015</b>	Design And Development Of A Peanut Roaster Machine	April 2013
<b>RSU-ME-014</b>	Design And Construction Of Snail Remover	March 2012
<b>RSU-ME-013</b>	Cassava Chipper And Grater: A Dual- Purpose Machine	March 2012



Romblon State University  
**COLLEGE OF ENGINEERING AND TECHNOLOGY**  
 Odiongan, Romblon  
*Tel.no. (042) 567-5588*

<b>RSU-ME-012</b>	Ricehull-Fed Dryer: Design, Construction And Initial Testing Of Cassava Chips Dryer	March 2012
<b>RSU-ME-011</b>	Modification And Performance Testing Of Tiger Grass Pollen Remover	March 2012
<b>RSU-ME-010</b>	Design And Fabrication Of Screw Conveyor	March 2012
<b>RSU-ME-009</b>	Portable Rice Dryer: Design And Construction Of A Flat Bed Dryer	April 2011
<b>RSU-ME-008</b>	Tiger Grass Pollen Remover: Design And Construction	April 2011
<b>RSU-ME-007</b>	Design And Construction Of Biomass Briquetting Machine	March 2010
<b>RSU-ME-006</b>	Design And Construction Of Cassava Grating Machine	March 2010
<b>RSU-ME-005</b>	Test Performance Of The Modified Rice Hull Gasifier Stove Developed At The Romblon State University- College Of Engineering And Technology	March 2010
<b>RSU-ME-004</b>	Design And Construction Of Briquetting Machine	March 2010
<b>RSU-ME-003</b>	Design And Construction Of An Air-conditioning System Using Water As Refrigerant	May 2009
<b>RSU-ME-002</b>	Design And Construction Of Aggregate Sieve Machine	April 2008
<b>RSU-ME-001</b>	Design And Construction Of Reel Mower Machine	March 2007
<b>Control No.</b>	<b>ELECTRICAL ENGINEERING Title</b>	<b>Date Submitted</b>
<b>RSU-EE-048</b>	Design and Development of a microcontroller based Solar Photovoltaic (PV) pump controller	July 2020
<b>RSU-EE-047</b>	Design and Development of an Automatic Power factor correction device for IIT at the Romblon State University- Main Campus	July 2020
<b>RSU-EE-046</b>	Maximization of Solar Photovoltaic Energy capture using combined passive cooling and solar tracking	July 2020
<b>RSU-EE-045</b>	Development of Synthetic Graphite/Polyurethane (sg/pu)- coated copper cathodes for seawater batteries	July 2020



Romblon State University  
**COLLEGE OF ENGINEERING AND TECHNOLOGY**  
Odiongan, Romblon  
*Tel.no. (042) 567-5588*

<b>RSU-EE-044</b>	Development and Testing of Secondary Electrical Marble Spool Insulator	April 2019
<b>RSU-EE-043</b>	Design and Development of wire temperature and overload monitoring device in residential electrical panel	April 2019
<b>RSU-EE-042</b>	Design and Development of waste heat recovery electric generator	April 2019
<b>RSU-EE-041</b>	Design, Development and testing of live wire tracing and ammeter device	April 2019
<b>RSU-EE-040</b>	Design, Development of safety monitoring and warning system device for Electrical System of the College of Engineering and Technology Building	April 2019
<b>RSU-EE-039</b>	Performance Evaluation of Romblon State University Agpudlos Campus Solar-powered water pump	April 2019
<b>RSU-EE-038</b>	Development and Evaluation of an Automated Solar-powered Auger-type fish feeder for Aquaponic System Application	April 2019
<b>RSU-EE-037</b>	Design Of Manually Operated Synchronizing Device For Diesel Power Plant	April 2018
<b>RSU-EE-036</b>	Design Of Underground Low Voltage Secondary Distribution System In Romblon State University (Main Campus)	April 2018
<b>RSU-EE-035</b>	Design Of Grid-Tied Solar Photovoltaic Roofing Of Romblon State University Quadrangle (Main Campus)	April 2018
<b>RSU-EE-034</b>	Design, Development And Evaluation Of An Automated Kilowatt-Hour Meter With Pilferage Protection System	April 2018
<b>RSU-EE-033</b>	Proposed Master Plan For Romblon State University, Main Campus Electrical System	April 2017
<b>RSU-EE-032</b>	Design, Development And Performance Evaluation Of A Solar Powered Arduino Based Heat Index Monitoring And Alarm Device (AHIMAD)	March 2017
<b>RSU-EE-031</b>	Design And Development Of An Arduino Based Solar Powered Bird Pest Deterrent Device For Agricultural Farm And Garden	March 2017
<b>RSU-EE-030</b>	Design, Development And Testing Of Solar Powered Automatic Sprinkler Irrigation System ( SPASIS)	March 2017
<b>RSU-EE-029</b>	Development Of A Portable RF-Based Remote Controlled Switching Device (RCSD) For Common Household Electrical Appliances	March 2017



Rombion State University  
**COLLEGE OF ENGINEERING AND TECHNOLOGY**  
Odiongan, Romblon  
*Tel.no. (042) 567-5588*

<b>RSU-EE-028</b>	Design And Development Of Arduino Based Transfer Switch System	March 2017
<b>RSU-EE-027</b>	Development Of A Prototype SMS Operated Switch For Lighting	March 2017
<b>RSU-EE-026</b>	Design And Development Of A Solar Charging Station For Laptop And Cell Phone	April 2016
<b>RSU-EE-025</b>	Design And Development Of Illumination Software For Interior Electric Lighting Calculation	April 2016
<b>RSU-EE-024</b>	Bluetooth Application For Water Supply Control System	April 2016
<b>RSU-EE-023</b>	Design And Development Of An Automated Micro-Irrigation Control System	April 2016
<b>RSU-EE-022</b>	Design And Development Of SMS- Based Fire Alarm Signaling System For Commercial And Residential Buildings	March 2016
<b>RSU-EE-021</b>	Development Of Graphite-Based Super Capacitor For Energy Storage	February 2015
<b>RSU-EE-020</b>	Development Of A Prototype Flood Level Monitoring System	February 2015
<b>RSU-EE-019</b>	Design And Development Of A 5200mah Solar Power Bank For Smart Phones And Tablet Charging	March 2015
<b>RSU-EE-018</b>	Design Of Service Lateral Line In The Romblon State University (Main Campus)	March 2014
<b>RSU-EE-017</b>	Design And Development Of Solar Powered Automatic Greenhouse Watering System At Romblon State University, Main Campus Climatic Condition	March 2014
<b>RSU-EE-016</b>	Design And Development Of Solar-Powered Programmable Automatic Chicken Feeder	March 2014
<b>RSU-EE-015</b>	Design And Development Of Prototype Automated Control And Monitoring System For Dams	April 2013
<b>RSU-EE-014</b>	Design And Development Of A Solar Powered Automated Fish Feeder	April 2012



Romblon State University  
**COLLEGE OF ENGINEERING AND TECHNOLOGY**  
 Odiongan, Romblon  
*Tel.no. (042) 567-5588*

<b>RSU-EE-013</b>	Feasibility Study For A Windmill As An Alternative Source Of Electricity At Punta, Looc, Romblon	March 2012
<b>RSU-EE-012</b>	Proposed Electrical System Design Of Romblon State University Biomass Gasifier Building	March 2012
<b>RSU-EE-011</b>	Database On Alternative Feedstock For Biomass Gasifier In Tablas, Province Of Romblon	October 2012
<b>RSU-EE-010</b>	Power Audit On Romblon State University Information Technology Development Center	August 2011
<b>RSU-EE-009</b>	The Use Of Light Emitting Diode As An Effective Lighting System In Homes And Industries	April 2011
<b>RSU-EE-008</b>	Assessment Of Electrical Wiring Installation Of The Odiongan Commercial Center In Odiongan, Romblon	April 2011
<b>RSU-EE-007</b>	The Evaluation Of Voltage Drop Of Electrical System Of Romblon State University, Main Campus Buildings And Premises In Compliance To PEC Requirements	April 2011
<b>RSU-EE-006</b>	A Tracer Study Of The Bachelor Of Science In Electrical Engineering Graduates Of Romblon State University Main Campus Odiongan Romblon	April 2010
<b>RSU-EE-005</b>	The Effectiveness Of Windmill Blades In Voltage Generation In Agpudlos, San Andres, Romblon: A Comparative Study	March 2010
<b>RSU-EE-004</b>	Photovoltaic: Source Of Power In Romblon State University Agpudlos, San Andres, Romblon	March 2010
<b>RSU-EE-003</b>	Street Lighting Of Romblon State University Main Campus Using Photovoltaic As Source Of Power ( Feasibility Study)	March 2010
<b>RSU-EE-002</b>	Awareness And Audit Of The Electrical Energy Consumption And Expenditures Of The Romblon State University Main Campus	March 2010
<b>RSU-EE-001</b>	The Effectiveness Of Smart Isolated Cell Sites In Tablas Island In The Province Of Romblon	March 2010
<b>Control No.</b>	<b>AGRICULTURAL ENGINEERING Title</b>	<b>Date Submitted</b>



Rombion State University  
**COLLEGE OF ENGINEERING AND TECHNOLOGY**  
 Odiongan, Romblon  
*Tel.no. (042) 567-5588*

<b>RSU-AE-017</b>	Design and Development of Mobile-based Agricultural and Biosystems Engineering Reviewer	April 2019
<b>RSU-AE-016</b>	Survey of existing Small Scale Irrigation System(SSIS) and identification of potential sites for Irrigation Development in three selected barangays of Odiongan Province of Romblon	April 2019
<b>RSU-AE-015</b>	Development and Evaluation of an A-frame seaweeds dryer constructed using bamboo and bamboo connectors	April 2019
<b>RSU-AE-014</b>	Development And Test Of A Solar-Powered Automated Misting Chamber For A Clonal Nursery For Beema Bamboo (" <i>Bambusa Balcoa</i> ")	April 2018
<b>RSU-AE-013</b>	Effects Of Different Particle Size Of Rice Straw On The Physical And Mechanical Properties Of Particle Board	April 2018
<b>RSU-AE-012</b>	Production Of Tilapia, Shrimp, Lettuce And Pechay In Solar Powered Pyramidal Recirculating Aquaponics System (Sopras)	April 2018
<b>RSU-AE-011</b>	Effects Of Different Levels Of Marble Dust As Cement Replacement In The Physical And Mechanical Properties Of Concrete Hollow Blocks (CHB)	April 2018
<b>RSU-AE-010</b>	Survey Of Agricultural Mechanization In Selected Municipalities Of Tablas Island, Province Of Romblon	April 2017
<b>RSU-AE-009</b>	Survey Of Copra Drying Practices Of Farmers In Selected Municipalities Of Tablas Island, Province Of Romblon	April 2017
<b>RSU-AE-008</b>	Development And Testing Of A Solar-Powered Pyramidal Recirculating Aquaponics System	March 2017
<b>RSU-AE-007</b>	Optimizing Rice Hull, Saw Dust, Wood And Level Of Binders For Fuel Briquettes	March 2016
<b>RSU-AE-006</b>	Development And Comparison Of Hydraulic Jack And Screw Type Operated Coconut Milk Extractors	March 2016
<b>RSU-AE-005</b>	Design, Fabrication And Performance Evaluation Of Fruits And Vegetables Scrap Shredder	March 2016
<b>RSU-AE-004</b>	Design And Construction Of Manually Operated Corn Seeder Machine	April 2013
<b>RSU-AE-003</b>	Performance Evaluation Of RSU Designed And Constructed Of Agricultural Waste Shredder	April 2012





Romblon State University  
**COLLEGE OF ENGINEERING AND TECHNOLOGY**  
Odiongan, Romblon  
*Tel.no. (042) 567-5588*

<b>RSU-AE-002</b>	Organic Fertilizer From Waste: Design And Construction Of An Organic Waste Shredder	July 2012
<b>RSU-AE-001</b>	A Survey On The Availability And The Extent Of Use Of Farm Machineries In Tablas Island, Province Of Romblon	March 2009

**Compiled by:**

**ENGR. REYNALDO P. RAMOS, PhD**  
Associate Professor  
Romblon State University  
Email Address: [rsu.rpramos2020@gmail.com](mailto:rsu.rpramos2020@gmail.com)

August 2020

# TITLE: BOLD, TIMES NEW ROMAN, FONT SIZE 16, 1.5 LINE SPACING

Author<sup>1</sup>, Author<sup>2</sup>, Author<sup>3</sup>, Author<sup>4</sup>

<sup>1</sup> Author Designation, Name of the Department, Institute Name, State, Country

<sup>2</sup> Author Designation, Name of the Department, Institute Name, State, Country

<sup>3</sup> Author Designation, Name of the Department, Institute Name, State, Country

<sup>4</sup> Author Designation, Name of the Department, Institute Name, State, Country

## Abstract

Abstract explanation should be Times New Roman, Font Size 10, Single line spacing, Italic, Text alignment should be justify, should contain at least 250 words. Abstract explanation should be Times New Roman, Font Size 10, Single line spacing, Italic, Text alignment should be justify, should contain at least 250 words. Abstract explanation should be Times New Roman, Font Size 10, Single line spacing, Italic, Text alignment should be justify, should contain at least 250 words. Abstract explanation should be Times New Roman, Font Size 10, Single line spacing, Italic, Text alignment should be justify, should contain at least 250 words. Abstract explanation should be Times New Roman, Font Size 10, Single line spacing, Italic, Text alignment should be justify, should contain at least 250 words. Abstract explanation should be Times New Roman, Font Size 10, Single line spacing, Italic, Text alignment should be justify, should contain at least 250 words.

**KeyWords:** Key word1, Key word2, Key word3, and Key word4 etc...

-----\*\*\*-----

## 1. HEADING 1

Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.

The reference number should be shown in square bracket [1].However the authors name can be used along with the reference number in the running text. The order of reference in the running text should match with the list of references at the end of the paper.

Eg1: As per Kong, the density of X increases with Y [9].

Eg 2: It is reported that X increase with Y [45].

### 1.1Sub Heading 1

Paragraph comes content here. Paragraph comes content here.

### 1.2Sub Heading 2

Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here.

## 2. HEADING 2

Paragraph comes content here.Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here.

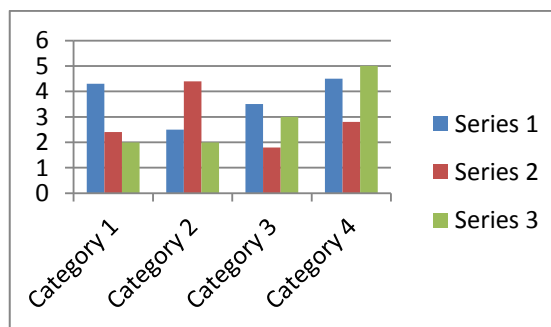
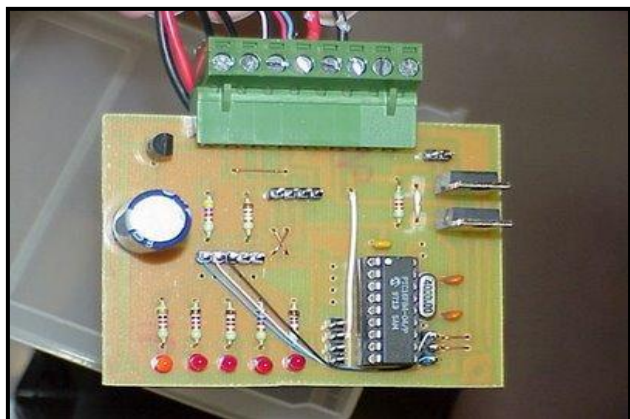


Chart -1: Name of the chart

Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here.

content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.Paragraph comes content here.



**Fig -1:** Name of the figure

Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.Paragraph comes content here. Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.

**Table -1:** Name of the Table

Col Name	Col Name	Col Name	Col Name	Col Name

Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.Paragraph comes content here.Paragraph comes content here.Paragraph comes content here.Paragraph comes content here. Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.Paragraph comes content here. Paragraph comes content here. Paragraph comes content here.Paragraph comes content here.

- List Item - 1
- List Item - 2
- List Item - 3
- List Item - 4

### 3. CONCLUSIONS

Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here.

content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here. Paragraph comes content here.

### ACKNOWLEDGEMENT

The authors can acknowledge any person/authorities in this section. This is not mandatory.

### REFERENCES

- [1]. Reference 1
- [2]. Reference 2
- [3]. Reference 3
- [4]. Reference 4

### BIOGRAPHIES

Author's Photo	Description about the author1 (in 5-6 lines)
-------------------	---

Author's Photo	Description about the author2
-------------------	-------------------------------

Author's Photo	Description about the author3
-------------------	-------------------------------

Author's Photo	Description about the author4
-------------------	-------------------------------

# A THREE-LEVEL DISPOSAL SITE SELECTION CRITERIA SYSTEM FOR TOXIC AND HAZARDOUS WASTES IN THE PHILIPPINES

Reynaldo Perez-Ramos<sup>1</sup>

<sup>1</sup>Associate Professor, College of Engineering and Technology, Romblon State University  
rsu.rpramos@gmail.com

## Abstract

One of the perennial problems in managing toxic and hazardous wastes (THWs) generated from industrial activities is the final storage and disposal area for such kind of wastes. Due to inadequate land surface disposal facility (LSDF) in the country, waste generators are continually practicing the WHIFFY (we-hide-it-freely-for years) approach; consequently becoming a threat to human health and the environment. Proper site selection for land surface disposal facility requires a consultative process, taking into consideration the various factors that affect the overall siting process towards an effective identification of land to be developed into acceptable and environmentally-safe land surface disposal structures. This paper attempts to establish a three-level site selection system through a participatory approach; and this is validated using survey questionnaire and secondary data. The establishment of a three-level site selection system facilitates the initial disposal siting process which leads to the development of technically, socially, environmentally, and politically acceptable disposal facilities for THWs in the Philippines. This paper also recommends basic guidelines to further support the site selection process with the application of computer-based spatial decision support systems such as Geographic Information System (GIS) as part of the land suitability assessment analysis.

**Keywords:** Toxic And Hazardous Wastes, Disposal Siting, Land Surface Facility, Site Selection, Geographic Information System.

\*\*\*

## 1. INTRODUCTION

### 1.1 Legal Basis in the THWs Management in the Philippines

A number of laws and regulations have already been passed and currently enforce in managing THWs from industrial operations. These are as follows: Republic Act 6969 – Toxic Substances and Hazardous and Nuclear Waste Control Act of 1990; Republic Act 8749, Republic Act 9003 - Ecological Solid Waste Management Act of 2001; Environmental Impact Statement (EIS) System of 1978; Presidential Decree 984 - Pollution Control Decree of 1976; and Philippine Nuclear Research Institute (PNRI) Administrative Order No.01, s.1990.

RA 6969 specifically regulates the generation, transport and disposal of THWs from industries, businesses and medical institutions. As defined by RA 6969, THWs are “*substances which present short and long-term environmental hazards, without any safe commercial, industrial, agricultural and or economic usage; and by-products, process residues, spent reaction media, contaminated plant items or equipment from manufacturing operations, and consumer discards that present unreasonable risk or injury to health and the environment.*”

The primary sources of THWs are the semi-conductor and electronics industry, the electroplating industry and power plants. Secondary sources include hospital and medical facilities, testing laboratories, universities and research centers which give additional burdens in the overall THWs management. Due to the limited capacity for recycling and

treatment of generated THWs in the country, industries handling waste acid, waste alkaline, waste oils, and sludge containing heavy metals are experiencing difficulty in managing it properly (Ex Corporation and Kokusai, 2001).

**Table 1** shows the 2014 data of THWs sources and composition based on the registration of generators by region in the country (DENR-EMB, 2015). The 2014 data indicate that NCR has the highest share (30.9%) of the number of registered THWs generators, followed by Region 3 (15.3%) and Region 4A (14.8%). There is a significant increase of generators in Region 3 compared to 1996 data of 4.6% share; while NCR dramatically decreased its generation from 1996 (47.2%) compared to 1.1% in 2014. Surprisingly, Region 5 has the highest share in the THWs generation with 93.9%, and 3.4% share in registered generators in 2014. The increase in registration and generation of THWs could be triggered by the strict compliance of RA 6969 and the economic and industrial development in the various regions.

In terms of type of THWs generation and composition (**Table 2**), Alkali wastes shared the highest percentage share of generation (90.81%), followed by waste with inorganic chemicals (4.55%), and miscellaneous wastes (1.80%). Specifically, Region 5 (Bicol) generated the highest volume of THWs with 93.9% share of the total generation of 17.7 million tons of THWs from the 15 regions. This was followed by Region 7 (Central Visayas) with 2.6% share, while Region 4A (Southern Tagalog) with 1.5% share, and NCR (Metro Manila) with 1.1% share. In particular, Region 4B (MIMAROPA) generated only 65.17 tons per year of mostly organic wastes.

**Table 1:** THWs Generators in the Philippines by Region, 2014

Region	No of Firms	No of Hospital	Total	% Share	THWs Generated	
					(ton/year)	% Share
NCR	4158	2474	<b>6632</b>	<b>30.9</b>	187,607.56	<b>1.1</b>
CAR	259	73	<b>332</b>	<b>1.5</b>	-*	<b>0.0</b>
CARAGA	342	91	<b>433</b>	<b>2.0</b>	38,777.00	<b>0.2</b>
Region 1	950	126	<b>1076</b>	<b>5.0</b>	1,467.93	<b>0.0</b>
Region 2	370	130	<b>500</b>	<b>2.3</b>	51.61	<b>0.0</b>
Region 3	3015	263	<b>3278</b>	<b>15.3</b>	-*	<b>0.0</b>
Region 4A	2931	239	<b>3170</b>	<b>14.8</b>	273,669.50	<b>1.5</b>
Region 4B	271	85	<b>356</b>	<b>1.7</b>	65.17	<b>0.0</b>
Region 5	644	86	<b>730</b>	<b>3.4</b>	16,639,462.88	<b>93.9</b>
Region 6	771	210	<b>981</b>	<b>4.6</b>	1,299.29	<b>0.0</b>
Region 7	1096	53	<b>1149</b>	<b>5.4</b>	451,877.11	<b>2.6</b>
Region 8	415	115	<b>530</b>	<b>2.5</b>	508.64	<b>0.0</b>
Region 9	204	70	<b>274</b>	<b>1.3</b>	688.46	<b>0.0</b>
Region 10	336	85	<b>421</b>	<b>2.0</b>	-*	<b>0.0</b>
Region 11	769	130	<b>899</b>	<b>4.2</b>	116,589.34	<b>0.7</b>
Region 12	480	190	<b>670</b>	<b>3.1</b>	280.88	<b>0.0</b>
<b>Total</b>	<b>17011</b>	<b>4420</b>	<b>21431</b>	<b>100.0</b>	<b>17,712,345.37</b>	<b>100.00</b>

Note: \*\_ No data provided

**Table 2:** THWs Composition and Type, 2014

Composition of Waste	Volume generated	% Share
Waste with Cyanide	<b>190,714.45</b>	<b>1.08</b>
Acid Wastes	<b>5,414.77</b>	<b>0.03</b>
Alkali Wastes	<b>16,083,724.12</b>	<b>90.81</b>
Wastes with Inorganic Chemicals	<b>806,175.49</b>	<b>4.55</b>
Reactive Chemical Wastes	<b>62.98</b>	<b>0.00</b>
Inks/Dyes/Paint/Resins	<b>134,834.29</b>	<b>0.76</b>
Waste with Organic Solvents	<b>27,969.08</b>	<b>0.16</b>
Organic Wastes	<b>352.79</b>	<b>0.00</b>
Waste Oil	<b>124,049.29</b>	<b>0.70</b>
Contaminated Containers	<b>13,254.72</b>	<b>0.07</b>
Stabilised Wastes	<b>4,629.12</b>	<b>0.03</b>
Organic Chemicals	<b>2,263.68</b>	<b>0.01</b>
Miscellaneous Wastes	<b>318,900.21</b>	<b>1.80</b>
<b>TOTAL</b>	<b>17,712,345.00</b>	<b>100.00</b>

The data also revealed that out of the total registered THW transporters/haulers of 195 in the country, Region 4A has 60 and zero in Region 4B. NCR has 56 registrants while Region 3 has 34 registrants. In terms of registered treatment-storage-disposal (TSD) facilities, there is one facility in Region 4B accredited and recognized by DENR.

Moreover, the existing Philippine regulatory framework encompasses the enforcement and compliance for the proper planning and management of THW, including general performance standards, waste classification and exemptions, waste generators registration, waste haulers/transporters/treaters accreditation, waste transport tracking and recording, storage and labeling, treatment, storage and disposal premises, and import/export

requirements. It also covers monitoring and enforcement of violations, fines and penalties as well as litigation and prosecution to ensure effective control and regulation of THWs will take place. Despite these regulatory instruments, THWs management in the country is not moving towards sustainability for several key reasons, namely: (a) lack of awareness and management systems of generators; (b) limited technical and financial capacities of haulers/transporters/treaters; and (c) insufficient and lack of enforcement of environmental laws and regulations (Ex Corporation & Kokusai, 2001).

Thus, these government policies placed additional burdens on the THWs generators. Because of a lack of available land surface disposal areas and appropriate treatment technologies, they will be forced to dispose of both untreated and treated THWs to waterways or to environmentally sensitive areas, and to municipal sanitary landfills or controlled dump sites. The existing environmental laws do not explicitly provide guidelines on siting or site selection criteria, which means that there is no legal basis on the disposal site selection for THWs. As the worst scenario, waste generators are continually practicing the WHIFFY (we-hide-it-freely-for years) approach – it means that waste generators dump or hide their THWs elsewhere; consequently becoming a threat to human health and the environment.

## 1.2 Site Selection and Development of Land Surface Waste Disposal Facility

The Philippine government is facing tremendous pressure from the communities where industrial zones are located, as well as from the industries on how to address the increasing generation of THWs. Generators are more concerned with the final disposal of their wastes after undergoing pre-treatment processes; on the other hand, the communities' fear is the health threat and environmental risks from illegal

dumping of untreated and residual wastes. Therefore, there is a need to develop a land surface disposal infrastructure, as one of the alternative solutions to address the problem. However, a major challenge faced by both the government and the private sector's locating suitable sites for THWs disposal. From the initial stage of development of looking for the best site, up to the final stage of implementing the project, requires a long process of approval. Where the facility will be located is also subject to the scrutiny of the community or individuals.

Site selection is the initial stage and the critical aspect of the land surface waste disposal development it requires proper planning to reduce administrative cost and lower the degree of disapproval from the constituents or even to prevent the project being rejected. Siting is a major part in waste management (Kao, et al, 1997), the most important step in land disposal (Gera, 1988), as well as a challenging and often controversial subject in itself. Apogee Research Inc. (as cited by Soesilo and Wilson, 1995) identifies three factors associated with successful siting: (1) the rate of success for on-site facilities was greater than for commercial facilities; (2) sites proposed on already industrialized land were more acceptable than those on non-industrial areas; and (3) storage, transfer and mobile treatment facilities were easier to site than other types of facilities.

Failure in land disposal site selection is contributed to by lack of financial support, appropriate site selection methodologies and public acceptance. Not-in-my-own-backyard (NIMBY) syndrome or public opposition is considered a perennial problem that leads to failure in the THWs site selection and implementation. Strong local opposition derives from either an inappropriate or incomplete siting analysis or the public's misunderstanding of the site selection procedure (Kao, et.al, 1997). Therefore, public participation is an integral part (Wentz, 1989) and an essential ingredient during the early stage of planning and prior to the start of the site selection process (Badilla-Ramos, 2000).

### 1.3 Spatial Decision Support System – Geographic Information System

The environmental sector started the earliest application of GIS focused on the land use planning, and it is widely used nowadays for intensive numerical and statistical analysis (Longley et al., 2001) in design and planning problems which involve multiple objectives and criteria such as waste management.

As cited by Orban-Ferauge (2011), GIS helps in formulating scenarios for the future due to their ability of visualizing, integrating, analyzing, and modeling giant databases associated with spatial references – also known as “geo-referencing”. Indeed, GIS is very powerful in connecting information in formulating scenarios. Longley et al., (2001) presented a huge range of GIS applications – utilities, education, banking and finance, market analysis, and military. This application is within the four major areas of

concern: local government, business, logistics and environment. GIS also serves as a powerful analytic and decision-making tool for management in testing consequences of development (Yi et al., 2003), and other environmental studies such as air or water quality analysis, disaster management, oil spills and remedial actions, hazard mitigations, forest fires management, etc. Eventually, the emerging popularity of GIS in infrastructure planning and management is also increasing.

Past undertakings in waste disposal facility site selection using various spatial decision support systems and models in a GIS environment vary depending on the availability of spatial digitized data needed to facilitate the GIS application in siting process (Badilla-Ramos, 2000). The spatial data required for the GIS to work are derived from the list of site selection or screening criteria translated from existing digitized base maps into thematic maps employed in the land suitability assessment analysis. Previous studies used a diverse range of siting criteria, most of which are based from existing regulations, studies (Siddiqui et al., 1996) and literature incorporating the spatial, social, economic, political and ecological dimensions of the problem (Kao et al., 1996). Likewise, previous methods use GIS capabilities only for screening out unsuitable or undesirable sites (Siddiqui et al., 1996). Therefore, the establishment and validation of these sets of criteria using computerized techniques make the decision making process faster, efficient, cost effective, and realistic.

The identification and importance ranking of the site selection criteria is an initial requirement stage of the siting process which involves inputs from the major stakeholders (i.e. waste generators, community organizations, individuals, decision makers, politicians, waste treaters/haulers, etc.). But most often the preferred criteria commonly used in GIS analysis are based on an individual's or expert's judgment, not from consultative, participatory and collective efforts of the major stakeholders in the community. The consultative approach in the establishment of the site selection criteria is relevant and timely to the existing situation of the Philippines, wherein there are no standardized guidelines in the site selection for land surface disposal facility development. The objective of this part of the study is to define, establish and assess the procedural requirements of GIS techniques using the proposed sets of siting criteria and available spatial data in the country. The results will be the basis for developing a workable disposal site selection framework maximizing the benefits derived from computer-based spatial support systems like GIS. It is not part of the study to produce suitability maps as a result of the GIS application, but rather, to assess the viability of suitability techniques vis-à-vis available datasets in the country.

### 1.4 Land Suitability Assessment Analysis in GIS Environment

One of the important considerations in land use planning is the allocation of the land for its optimal use. In other words, land is allocated for the purpose for which it is most suited

(Apan, 1996) or potentially capable of such use. Proper designation of land use reduces the negative impacts of such use to the environment. The need for sound and effective evaluation in land suitability assessment for THWs disposal facility site selection is necessary to minimize the NIMBY (not-in-my-backyard) attitudes among the major stakeholders. Proper assessment will also reduce any potential problems with regards to the technical requirements for such infrastructure development. Due to limited funds and resources, it is important to have a clearer framework for choosing the most suitable sites. This necessitates considerable amount of information to support such siting.

Site selection is considered as a spatial problem which involves large volume of data that can be stored, analyzed and displayed in a GIS environment (Basnet et al., 2001). In addition, the evaluation process does not only include the environmental, biophysical, and political attributes of the land resource, but it also includes the social factors dealing with spatially related information.

Currently, GIS is able to select, rank and map sites that are suitable or unsuitable for a specific purpose (Basnet et al., 2001; Davis, 1996). Overall, land suitability assessment for site selection can benefit from the application of GIS in terms of: (a) capturing, storing, and managing spatially referenced data, (b) providing and performing analysis of massive amounts of spatial data, (c) performing sensitivity and optimization analysis, and (d) communicating model results (Vatalis & Manoliadis, 2002; Kao, 1997). Thus, GIS becomes powerful for gaining consensus before decision-making (Apan, 1996).

As cited by Biermann (1999), land suitability assessment is an essential aspect of land identification process to quantify the potential and constraints factors of developing the lands; and evaluates and prioritizes the available lands based on those identified factors. Land suitability evaluation is also involves land identification for future use patterns, and the economic and environmental feasibility of its current use. There are four major stages of the land suitability assessment, namely: (1) criteria identification and selection, (2) criteria quantification and standardization, (3) criteria weighing and summation, and (4) criteria overlay. These stages of assessment are being integrated to other multi-criteria spatial decision support systems such as Analytic Hierarchy Process (AHP) and GIS.

## 2. OBJECTIVES

The main goal of the study is to establish a site selection criteria system in locating feasible land surface disposal areas in the Philippines and be able to implement this system using computer-based support systems like GIS. Specifically, the study also discusses the current problems and issues in managing THWs in the country; establishes a set of screening or siting criteria through a participatory approach; and recommends a workable spatial support planning framework or procedure in THWs land surface disposal site selection for GIS application.

## 3. METHODOLOGY

A qualitative type of research was adopted to successfully meet the objectives of the study. The research methodology covered the review of relevant studies, conduct of actual interviews and surveys, as well as site inspection of existing land surface disposal facilities in the country.

A survey was conducted mainly in Metro Manila, its neighboring provinces and CALABARZON (Cavite-Laguna-Batangas-Rizal-Quezon) area. In total, sixty-seven (67) respondents and grouped into three major respondents using a structured questionnaire. These groups include (a) primary-generators group – industries and companies primarily generate and are sources of THW, (b) secondary-generators group – industrial park/estate and hauling/treating facilities, and (c) non-generators group - private individuals, as well as professional and community organizations. The target groups of respondents were identified based on the author's knowledge that these groups are the main players in THWs management as well as from the past studies. The set of questionnaires or survey forms mainly covered the identification of the level of awareness of the target groups of respondents with regard to their current practices in managing THWs, issues and problems in final disposal of the untreated and treated THWs. The significant part of the survey was the identification and ranking of the set of screening criteria in terms of applicability, relevance and importance to the disposal site selection process.

A three-level site selection or screening criteria system was proposed based from the results of the survey and validated during the consultation process. Consequently, a two-level multi-criteria decision support framework was designed to facilitate the assessment of the land's level of availability and suitability to be developed into acceptable THWs disposal sites. This conceptual analytical model is a procedural framework on how to undertake the land suitability assessment integrated with multi-criteria evaluation such as ranking weighing techniques, Pairwise comparison (AHP), and GIS (map overlay using weighted linear modeling).

## 4. RESULTS AND DISCUSSIONS

### 4.1 The Three-Level Disposal Site Criteria/Screening System

The proposed Three-Level Disposal Site Criteria/Screening System was adapted from Cahill and Holman (Ramos, 2005). In the new proposed system, the criteria for each level were modified and expanded, incorporating additional information from the existing literature in terms of degree of applicability, importance and relevance to the disposal selection process in the country. In addition, the importance rankings of each criterion derived from the results of the survey participated by three major groups of respondents or stakeholders were included in the proposed system.

The proposed site selection system consists of three levels of siting or screening criteria. The **Level I criteria** -

“exclusionary criteria” exclude or eliminate sensitive or environmentally critical areas such as: areas with hydrologically and geologically sensitive characteristics, areas subject to flooding and erosion, and other areas that make a valuable contribution towards land conservation and preservation. The **Level II criteria** - “inclusionary-preferred criteria” include or contain favorable areas/sites such as: present location of THW generators, haulers, and treaters; existing and proposed municipal landfill sites and controlled dump sites, as well as proposed radioactive depositories; proximity to major transportation network; existing industrial zones; location of contaminated sites and abandoned mining sites. Finally, the **Level III criteria** or the “site-specific criteria” investigate both favorable and unfavorable characteristics of the sites/areas that have passed the previous two levels. This covers hydrogeology characteristics, climatic condition, biological and ecological consideration, economic and social aspects and the overall physical development plan of the area.

The results of the study suggested that the three major groups of respondents have a high awareness of the adverse externalities of poor disposal of THW to the natural environment particularly on water quality, which will have high social and economic costs in the future. The final ranking of selection criteria for each level is summarized in **Table 3**.

**Table 3:** The Three Level Disposal Site Selection / Screening Criteria System

#### Level I. EXCLUSIONARY CRITERIA

1. *Hydrological Characteristics* - wetlands, source of freshwater aquifer and critical areas and water supply, watershed areas;
2. *Other Environmentally Sensitive Areas* - natural and historical landmark, watershed reserved area, agricultural area, protected and natural forests and parks, tourism development area, and other sensitive areas identified by existing laws;
3. *Flooding and Erosion Conditions* - coastal flood hazard area, cyclonic area, landslide prone area, and other floodplain and storm surge areas; and
4. *Geological Characteristics* - volcanic and lahar risk zone, seismic risk and impact zone, earthquake fault line, unstable terrain due to mining activity and abandoned oil and gas wells.

#### Level II . INCLUSIONARY CRITERIA

1. *Location of Existing Treatment, Storage and Disposal (TSD) Facilities* - accessibility to THW materials, and existing location of haulers/transporters/treaters/recyclers;
2. *Location of existing and proposed municipal landfill sites* - present and propose disposal sites for identified sites for municipal solid waste either sanitary landfill or controlled open dump sites;
3. *Transportation Network* - accessibility to major arterial transport networks both land and water;
4. *Land Use and Ownership* - land use designated for industrial purposes or development government-owned or public lands; and

5. *Other Criteria* - location of proposed radioactive repository sites, proximity to sources of THWs, location of identified contaminated sites, location of existing and abandoned mining sites.

#### Level III. SITE-SPECIFIC CRITERIA

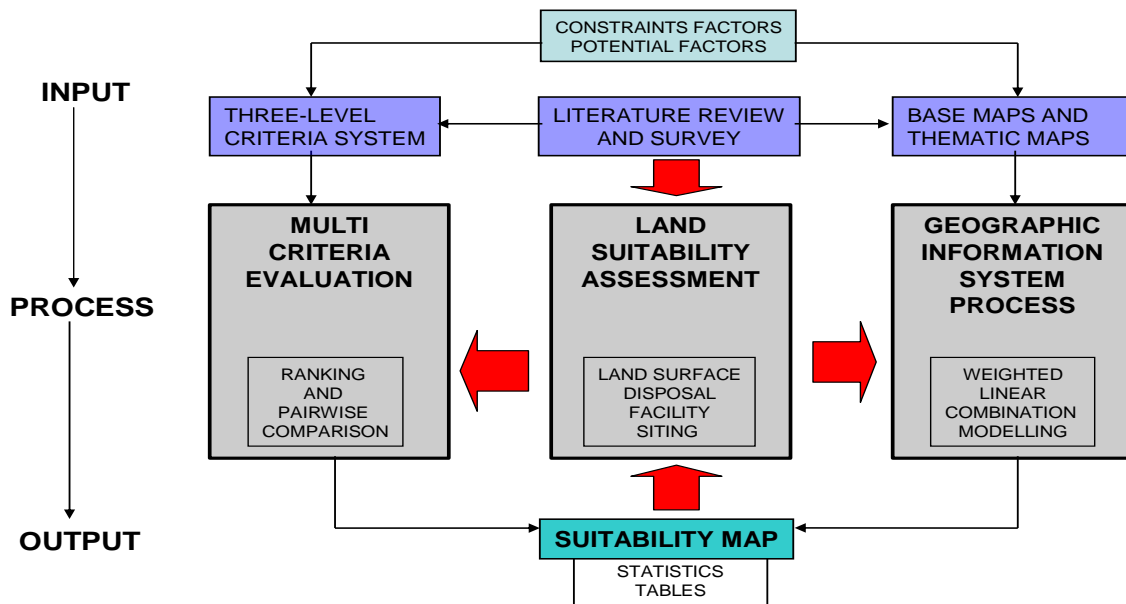
1. *Hydrogeology* - surface water characteristics, groundwater characteristics, geological condition, soil condition and structure, soil erosion and deposition;
2. *Biological Consideration* - critical habitat; scenic and recreational area, farmland preservation area, marine life preservation, other sensitive vegetation;
3. *Social Consideration* - community benefits, population density, health profile, availability of services and utilities, and other demographic data such income, employment;
4. *Climatic Condition* - air quality, wind direction/patterns, noise and odour levels;
5. *Economic Consideration* - land property value, land ownership/tenure, site development cost, site life and size, compensation arrangement for affected communities; and
6. *Other Criteria* - transportation network, comprehensive physical development plan, ecological consideration, and archaeological significance.

## 4.2 Conceptual Analytical Framework: A Two-Level Multi-criteria Decision Support System

A conceptual analytical framework is designed to facilitate the assessment of the lands' level of availability and suitability to be developed into acceptable THWs disposal sites as shown in **Figure 1**. This model is a procedural framework on how to undertake the land suitability assessment integrated with Multi-criteria evaluation and GIS processes. Multi-criteria evaluation and GIS are considered powerful in the process of assessing the suitability of land (Biermann, 1999). Thus, the model illustrates the integration of multi-criteria evaluation using ranking weighing techniques, Pairwise comparison (AHP), and GIS (map overlay using weighted linear modeling). A simple “ranking technique” is applied to determine the importance level of the individual criterion in each siting level. The resulting rankings are subjected to Pairwise comparison technique using the AHP method for further validation based on the author's judgment.

The Three-Level Site Selection/Screening Criteria System provides the primary identification of the selection of factors and data acquisition for this part of the study. Based from the secondary sources, it showed the unavailability of the datasets in digital format is a problem. Only selected local government units' administrative boundaries have been converted into digital form and mostly in paper format. Few of these available maps are relatively recent. Furthermore, relevant data layers (themes) need to be in a digitized format. In this case, most of the available datasets required in this study require manual digitizing using available software in the market to produce vector coverages.





**Figure 1:** Conceptual Analytical Spatial Decision Support Framework

According to Basnet et al. (2001), most of the previous studies involved a vector-based method to identify landfill sites in the United States, dumpsites in Malaysia, municipal waste disposal sites in the Philippines, and animal waste application in Australia. However, in this study a raster-based method will be employed for reasons stated by Eastman, et al. (1993) as follows: (a) it has more analytical power in the analysis of continuous space; (b) it is ideally suited to the study of data that are continuously changing over space such as terrain, vegetation biomass, rainfall, etc.; (c) its structure closely matches with the architecture of digital computers; and (d) it tends to be rapid in the evaluation of problems that involve various mathematical combinations of the data in multiple grids.

After applying appropriate digitizing techniques to avoid generation and propagation of errors, topology creation and geo-referencing are executed, followed by conversion of the vector coverages into raster-based data (Apan, 1996).

### 4.3 Data Analysis: Multi-criteria Evaluation and GIS Operation

The data analysis involves two major stages: multi-criteria evaluation using the Pairwise comparison technique and the criteria (factors) overlay using the weighted linear modelling in a GIS environment. The accuracy of the results of the analysis is dependent on the available datasets for constraint factors and potential factors represented in thematic layers. Moreover, the assessment of the relative ranking and scoring for each factor using the Pairwise comparison affects the outcome of the suitability analysis (Apan, 1996).

A multi-criteria evaluation (MCE) is a decision making tool which defines objectives, formulate criteria and evaluate solutions based upon spatial properties and preferences (Pullar, 1999). One of the important steps in the MCE approach is the articulation by decision makers (i.e.

stakeholders) of the varying importance (preference) they give relative to the criteria. The preference is an expression of stakeholder's values, and in the MCE perspective it is the varying degrees of importance assigned to criteria. Criterion Weighing Techniques are the common methods to illustrate those multi-criteria that have varying importance. Each criterion is assigned a numeric value – weight that indicates its importance relative to other criteria in the decision situation. The weights are normalized so that the sum of all the criteria under consideration equals to 1. Under these techniques, two methods are employed in the study to assess the importance rating of the criteria under consideration. The results in the establishment of the Three-level site Selection/Screening Criteria System will be subjected to Ranking Method and Pairwise Comparison.

AHP is used to derive the weights of each criterion which employs a Pairwise comparison procedure to come up with a scale of preference sets of criteria and gives a measure of consistency of judgments applied in deriving the weight for each criterion and factor (Apan, 1996). AHP has been applied in various settings with complex decision problems (Siddiqui, et al., 1996). As noted by Siddiqui et al. (1996), AHP is applied in landfill siting studies, health care, space exploration, urban planning, and politics. AHP can be applied using IDRISI's built-in function (Basnet, et al., 2001) or can be done manually using the following mathematical formulas and sequence of steps (Yi, et al., 2003; Apan, 1996). Due to limited datasets for IDRISI's application, the manual computation presented here is only a preliminary assessment and validation of the siting criteria ranked by the major stakeholders. The tabulated weights for each criterion and the factors under each criterion are determined and interpreted by the author using the nine point rating scale (Davis, 2002; Apan, 1996), where from 1 = relative to the column variable, the row variable is equally important, and to 9 = relative to the column variable, the row variable is absolutely more important.

To illustrate this with exclusionary criteria as shown in **Table 4**, row A variable which is criterion 1 is compared to column A variable (criterion 1), the weight assigned is 1 which means that criterion 1 compared to the same criterion is equally important. On the other hand, row A variable (criterion 1) has a weight of 5 in relation to the column B variable (criterion 2), which means that criterion 1 is more important or five times important than criterion 2. This

means that criterion 1 is important than criteria 2, 3 and 4 in varying level of importance based on the established rating scale. Another scenario of comparison is demonstrated between criterion 2 (row B variable) and criterion 1 (column A variable). The assigned weight for criterion 2 is 1/5 which only means that this criterion (column B variable), is relatively five times less important than the criterion 1 (column A variable).

**Table 4:** Tabulated Weights using Pairwise Comparison Method

	Exclusionary Criteria	A	B	C	D	AVE RANK	RANKING	WT
A	Criteria 1	1	5	7	9	1.23	1	0.1
B	Criteria 2	1/5	1	3	5	1.42	2	0.2
C	Criteria 3	1/7	1/5	1	3	1.52	3	0.3
D	Criteria 4	1/9	1/7	1/3	1	1.66	4	0.4
	Total	1.45	6.34	11.33	18.00		TOTAL	1.0

		A	B	C	D	Row total	Row average
A	Criteria 1	0.69	0.79	0.62	0.50	2.59	<b>0.65</b>
B	Criteria 2	0.14	0.16	0.26	0.28	0.84	<b>0.21</b>
C	Criteria 3	0.10	0.03	0.09	0.17	0.38	<b>0.10</b>
D	Criteria 4	0.08	0.02	0.03	0.06	0.18	<b>0.05</b>

*Next steps are for calculating consistency of the ranking*

Row average	0.65	0.21	0.10	0.05
-------------	------	------	------	------

	Vector C
A	2.78
B	0.86
C	0.37
D	0.18

consistency index (CI)= **0.01**

N	1.00	2.00	3.00	4.00	8.00	9.00	10.00	11.00
RI	0.00	0.00	0.58	0.90	1.41	1.45	1.49	1.51

For calculation of RI=0.90,  
the consistency ratio (C.R.) = 0.01

After assigning weights for each criterion or factor, the weights are added to determine the total weights and for calculating the priority weights. The priority weights for each different factor or criterion are determined by dividing each individual assigned weight with the total weights (computed from the first matrix). Row total weights are computed from the sum of the priority weights for all different criteria or factors (in columns). Each row average weight (vector B) is calculated by dividing the row total

weights by the total number of factors or criteria used and multiply with 100 as normalization of 100%.

To determine the consistency of ranking, each row weight from the paired comparison from the first matrix are multiplied by the principal vector or priority weights (row average) to get the new vector (vector C). The average vector C is the sum of the entire individual new vector for each criterion or factor. Each average vector C is divided by its corresponding row average weight (vector B) to calculate

the new vector D. The average weight for the calculated new vector D is called the maximum eigen value "lamda max". This value will be utilized in the determining the consistency index (CI), subsequently for the calculation of random index (RI) and consistency ratio (CR).

The results show that the author's judgment towards the respondents' ranking for all levels criteria is acceptable. The consistency ratios are within the consistency ratio (CR) based on Saaty's (1990) empirical suggestion of 0.10 which is acceptable. Smaller results are more consistent in Pairwise comparison.

#### 4.4 GIS Process

The role of GIS is to facilitate the mapping and calculation of the degree of suitability and availability of sites that are potentially capable to be developed into land disposal areas. The calculation is based on the sets of criteria discussed earlier using the weighted linear combination model. GIS also provide the analysis of both spatial and attribute data using ArcView, ARC/INFO programs or IDRISI.

At this stage of the suitability analysis, all the constraints and potential factors are already translated into thematic maps. For Level I: Exclusionary Criteria (Constraint Factors), it is recommended that a map scale of 1:250,000 for this level can be applied. It means that all the constraint factors will be screened in a 1:250,000 scale digitized map. This screening approach reduces the volume of data to be processed for further GIS operation. Level II: Inclusionary Criteria (Potential Factors) will be done either in a 1:100,000 or 1:75,000 map scale, and Level III: Site-Specific Criteria will be subjected to a 1:50,000 map scale.

The site suitability level is determined by calculating the suitability index (SI). SI for each cell or grid is determined by aggregating relative importance weights (RIWs) at each level of the criteria or factors hierarchy (Siddiqui et al., 1996). RIWs are the values of the weights derived from the Pairwise comparison (AHP technique). Within GIS application, SIs for all raster cells are determined simultaneously using map algebra function. The higher the suitability number for a given cell, the more suited the raster cell is to be selected as a potential site for disposal (Siddiqui, et al., 1996). The SI can be also classified into areas of high, medium, and low suitability within the GIS software function (Basnet et al, 2001). As cited by Basnet et al (2001), this method identifies natural breakpoints by looking for groupings and patterns inherent in the data. The writer added that coefficient of variation, weighted standard deviation, and weight averages of SIs are computed to have full understanding of the overall degree of suitability.

#### 5. CONCLUSIONS

This paper aimed to develop and establish a set of site selection or screening criteria which could be proposed towards improvement in the current disposal siting practices in the Philippines. In spite of government policies on THWs management, problems and issues have persisted due to the

lack of standard criteria for siting as well as an institutionalized site selection process.

The lack of a centralised land surface facility for THWs has aggravated the situation. The dynamic pace of industrialization and urbanization in the country lends itself to the need for proper site selection and allocation of land for the construction of a disposal facility. This would be an important indicator for environmental sustainability. Presumably, land scarcity was not an issue in the establishment of a centralized disposal facility; the problem lies much more in the absence of a standardized site selection or screening mechanism. It is also important to gain public support in disposal site selection and development.

The Three-Level Site Criteria System developed in this study would significantly contribute to the improvement of the site selection or screening practices in the country. Broadly, it could be utilized in three ways. First, the proposed system could used to validate the existing criteria employed by most Consultants. Second, the adoption of the conceptual analytical framework validation using a computer-based spatial support system such as the Geographic Information System (GIS) influence the standardisation of criteria site selection mechanisms, particularly it will improve the present "ad-hoc" approach for the site selection of the land surface disposal facility in the country. Thus, integration of this framework with other existing planning and management tools such as land use planning, environmental impact assessment, and strategic planning will bring a holistic approach of disposal site selection and development.

#### 6. REFERENCES

- [1] Apan, A. (1996) *Land Resource Survey and Evaluation for Tropical Forest Rehabilitation: Approaches Using Satellite Imagery and GIS*. Thesis submitted in the Department of Geography and Environmental Science, Monash University, Australia.
- [2] Badilla-Ramos A. (2000) *Draft Report. Part 1 and 2. Development of a Computer-Aided Tool for siting Sanitary Landfills (CATSSAL) in the Philippines*, Ph.D. Thesis, Griffith University, Brisbane, Australia.
- [3] Basnet, B., Apan, A., Raine, S. (2002) Geographic Information System based Manure Application Plan. *Journal of Environmental Management*, 64 99-113.
- [4] Biermann, S. (1999) *The Strategic Identification of Suitable Land for Low Income Housing: A Case Study from South Africa, Spatial Multicriteria Decision Making and Analysis*. Jean-Claude Thill (eds), Ashgate Publishing Ltd, England.
- [5] Cahill L.B. and Holman W.R. (1981) *Siting Waste Management Facilities. Hazardous Waste Management*, Ann Arbor Science Publishers, pp.86-97.
- [6] Davis, B. (1996) *GIS A Visual Approach*. On Word Press, Santa Fe, USA.
- [7] Department of Environment and Natural Resources (1995) *Orientation Manual for the Implementing Rules and Regulations for Title II. The Management of*

- Chemicals and Toxic Substances, DENR Administrative Order.29, Republic Act 6969, EMB, Manila.*
- [8] Department of Environment and Natural Resources (1995) *Orientation Manual for the Implementing Rules and Regulations for Title III. The Management of Hazardous Waste, DENR Administrative Order.29, Republic Act 6969, EMB, Manila.*
- [9] Entec Europe Ltd., ECOTEC Research and Consulting Ltd, and Dames and Moore (1996) *Toxic and Hazardous Waste Management Project*, Metro Manila, Philippines.
- [10] Environmental Management Bureau (2015) *Regional Distribution of Hazardous Waste Generation Amount by Type of Hazardous Waste*, Environmental Quality Division – Hazardous Waste Management Section, DENR, Quezon City.
- [11] Eastman, R., Kyem, A., Toledano, J., Weigen, J. (1993) *GIS and Decision Making: Explorations in Geographic Information Systems Technology*, UNITAR, Geneva.
- [12] Ex Corporation and Kokusai Kogyo Co., Ltd. (2001) *Japan International Cooperation Agency (JICA) Final Report. The Study on Hazardous Waste Management in the Republic of the Philippines (Phase 1)*, Manila.
- [13] Gera, F. (1988) Modelling Long Term Impacts of Land Disposal of Hazardous Waste, *Land Disposal of Hazardous Waste: Engineering and Environmental Issues*, Gronow, J.R. Schofield, A.N., Jain, R.K. (eds.) Ellis Horwood Limited, England.
- [14] Kao J., Lin H. and Chen, W (1997) *Network Geographic Information System for Landfill Siting. Waste Management and Research*, 15, 239-253.
- [15] Longley, P., Goodchild, M., Maguire, D., Rhind, D. (2001) *Geographic Information Systems and Science*, John Wiley and Sons, Ltd., Chichester, England.
- [16] Orban-Ferauge, F. (2011) *Participatory geographic information systems and land planning: life experiences for people empowerment and community transformation*, FUNDP, Namur, Belgium.
- [17] Portney, K. (1991) *Siting of Hazardous Waste Treatment Facilities. The Nimby Syndrome* Auburn House, CT, USA.
- [18] Pullar, D. (1999) Using an allocation Model in Multi Criteria Evaluation. *Journal of Geographic Information and Decision Analysis*, Vol 3, No 2, 9-17.
- [19] Ramos, R. (2005) Infrastructure Siting Development for Land Surface Disposal of Toxic and Hazardous Wastes in the Philippines, Mphil Thesis, University of Queensland, Brisbane, Australia.
- [20] Ramos, R.P. (2003) *Waste Management in Developing Countries. A Case Study of the Toxic and Hazardous Waste in the Philippines*, A paper presented and published in the Environmental Research Event (EERE) Conference Proceedings, Mowlaei, Rose and Lamborn (eds), pp305-314, Melbourne, Australia.
- [21] Saaty, T.L. (1990) *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation*, Pittsburg, RWS Publications.
- [22] Siddiqui, M., Everett, J., Veux B. (1996) Landfill Siting Using Geographic Information Systems: A Demonstration. *A Journal of Environmental Engineering*, June 1996, 515-523.
- [23] Soesilo, A. & Wilson, S. (1995) *Hazardous Waste Planning*, CRC Press, Inc., Florida.
- [24] United States Environmental Protection Agency (1995) *Process Design Manual, Surface Disposal Sewage Sludge and Domestic Septage*. US-EPA, Washington, D.C., USA.
- [25] U.S. Environmental Protection Agency (1995) *Process Design Manual for Surface Disposal of Sewage Sludge and Domestic Septage*, USA.
- [26] Vatalis, K. & Manoliadis, O. (2002) A Two-level Multicriteria DSS for Landfill Site Selection Using GIS: A Case Study in Western Macedonia, Greece, *Journal of Geographic Information and Decision Analysis*, Vol 6, No 1, 49-56.
- [27] Wentz, Charles A. (1989) *Hazardous Waste Management*. McGraw-Hill, Inc., New York.
- [28] Yi, D., Lulu, N., Lin, K., & Diana, S (2003) Application of GIS and Remote Sensing for Assessing Watershed Ponds for Aquaculture Development in Thai Nguyen, Vietnam, *Map Asia*, Malaysia.

## BIOGRAPHIES



**Engr. Ramos** is an Associate Professor of the College of Engineering and Technology of the Romblon State University, Philippines. A registered Civil Engineer, Engr. Ramos has a PhD degree in the Built Environment at the University of Ulster, Northern Ireland, UK. He got MPhil degree in Environmental Engineering at the University of Queensland, Australia. His research area of interests include geographic information system, environmental impact assessment, environmental management system, water quality of river systems, urban regeneration, and green building.