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DEDICATION

For my beloved mother and father

ACKNOWLEDGEMENT

The author would like to express his sincere appreciation to his supervisor, Prof. Dr. xxx for the support given throughout the duration of this research. The cooperation given by the Department of Water Resources Johor is also highly appreciated. Appreciation also goes to everyone involved directly or indirectly towards the compilation of this thesis. Last but not least,.....

ABSTRACT

Video provides a powerful way to help you prove your point. When you click Online Video, you can paste in the embed code for the video you want to add. You can also type a keyword to search online for the video that best fits your document. To make your document look professionally produced, Word provides header, footer, cover page, and text box designs that complement each other. For example, you can add a matching cover page, header, and sidebar. Click Insert and then choose the elements you want from the different galleries. Themes and styles also help keep your document coordinated. When you click Design and choose a new Theme, the pictures, charts, and SmartArt graphics change to match your new theme. When you apply styles, your headings change to match the new theme. Save time in Word with new buttons that show up where you need them. To change the way a picture fits in your document, click it and a button for layout options appears next to it. When you work on a table, click where you want to add a row or a column, and then click the plus sign. Reading is easier, too, in the new Reading view. You can collapse parts of the document and focus on the text you want. If you need to stop reading before you reach the end, Word remembers where you left off - even on another device.

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LIST OF SYMBOLS AND ABBREVIATIONS

D, d	- Diameter
F	- Force
G	- Gravity = 9.80 m/s^2
I	- Moment of Inertia
l	- Length
m	- Mass
P	- Pressure
Q	- Rate of Flow
r	- Radius
T	- Torque
Re	- Reynolds Number
V	- Velocity
x	- Shift
Z	- High
$UTHM$	- Universiti Tun Hussein Onn
$UNESCO$	- United Nations for Education, Science, and Cultural Organization

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CHAPTER 1

INTRODUCTION

1.1 Research Background and Motivation

Microsoft Word Templates (DOTX) are designed to simplify the formatting process, ensuring consistency, professionalism, and adherence to academic standards in your thesis documents. These templates come with pre-defined styles that automate spacing, alignment, and layout adjustments, reducing the time and effort required to format your work manually. Students should adhere to the following text spacing guidelines to maintain consistency and professionalism in their thesis formatting.[1], [2], [3], [4], [5], [6], [7], [1], [8], [9], [10].

The spacing between the **upper margin of the page** and the **chapter number** should be set at **THREE (3) lines**, while the spacing between the chapter number and the **chapter title** should be set at **ONE (1) line**. These requirements can be easily fulfilled using the Microsoft Word (DOTX) template. Simply apply **Style > CHAPTER 1 HEADING 1**, and the layout will automatically adjust as needed.

The spacing between the **chapter or subtitle** and the **first line of text** should be set at **ONE (1) line**. Subtitles, including their numbering, must be aligned with the left margin. By using the DOTX template, you can automatically apply these formatting adjustments to all thesis chapters or subtitles by using the following styles:

By utilising the Microsoft Word Template (DOTX), these predefined styles ensure that your thesis adheres to the required formatting standards. This approach not only promotes uniformity but also significantly reduces the complexity of document formatting, allowing you to focus more on the content of your thesis.

1.2 Managing and Formatting The Paragraph

In this template, formatting the first paragraph of a chapter or subtitle begins with the first sentence starting at the left margin and being fully justified. If the chapter contains only one paragraph, ensure that the spacing between the following subtitle and the last line of the preceding text is set to one (1) line. This formatting can be achieved by applying the **Style > Paragraph First and Last**, which will automatically adjust the layout for you.

1.2.1 Subheading No 1

If the chapter or subtitle contains more than one paragraph, ensure that there is no spacing between the paragraphs. To achieve this, use the **Style >Paragraph First Cont'd**, which *automatically* applies the appropriate formatting.

Subsequent paragraphs within the same chapter or subtitle should be indented by one tab from the left margin and fully justified. If there are multiple subsequent paragraphs, ensure that there is no spacing between them. You can accomplish this by using the **Style >Paragraph Second Cont'd**, which will handle the formatting *automatically*.

In the last paragraph of a chapter or subtitle, the first sentence should begin with an indent of one tab from the left margin and be fully justified. Additionally, there should be a spacing of one line between the last line of this paragraph and the next subtitle. Use the **Style >Paragraph Upward and Last** to apply these settings seamlessly. These pre-defined styles in the template simplify formatting tasks and ensure consistency throughout your document, from chapter headings to the final paragraph.

1.2.1.1 Tertiary heading no.1 (Under Subheading no. 1)

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1.2.2 Subheading No.2

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1.2.2.1 Tertiary heading no. 2 (Under Subheading no. 2)

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1.3 Problem Statement

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Themes and styles also help keep your document coordinated. When you click

Design and choose a new Theme, the pictures, charts, and SmartArt graphics change to match your new theme. When you apply styles, your headings change to match the new theme.

1.4 Research Objectives

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1.5 Research Hypotheses

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1.6 Research Questions

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your document look professionally produced, Word provides header, footer, cover page, and text box designs that complement each other. For example, you can add a matching cover page, header, and sidebar.

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1.7 Scope and Delimitation

1.8 Significance of Study

1.9 Thesis Outline

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Type your text here (Hassan et al., 2021). [11]

2.1.1 Heading 2

Type your text here as shown in Figure 2.1.

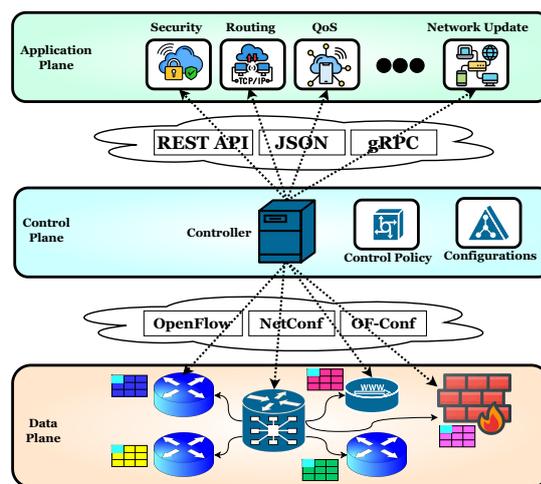


Figure 2.1: Sample system architecture.

2.1.2 Type Your Subtitle Here

Tables in the thesis must be numbered in Arabic numerals, linked to the respective chapter number (e.g., the first table in Chapter 2 is labelled "Table 2.2"). The caption must appear above the table, be justified, without a period at the end, and single-spaced between lines for each table and the text within the table should be written using the font size used in the document (as in the thesis writing guideline) and single spaced between the lines. If a table spans multiple pages, denote its continuation on the subsequent page as, for instance, "Table2.1 (continued)."

Table 2.1: Number of Reviewed Journals with respect to Publication Source

Name of Journal	No	Name of Journal	Articles
A Journal Science	1	Journal of Business Marketing	1
Academy of you	1	Journal of Business Research	6
Academy journal	1	Journal of Business and Industrial	1
Annals of Regional	4	Journal of Business and Venturing	3
Asia Pacific	1	Journal of Commercial Biotechnology	2
Asian Innovation	1	Journal of Innovation Management	1
Asian Management	1	Journal of Innovation and Entrepreneur	1
Asian Social	1	Journal of Operations Management	2
African Journal	2	Journal of Product and Brand	2
Baltic Journal	1	Journal of Management Studies	4
British Journal	1	Journal of Management & Organization	1
Creativity	1	Journal of Communication	1
European Journal	2	Journal of Small and Business	1
European Journal	1	Journal of Technology Transfer	12
Expert Systems	2	Long Range Planning	2
Industrial Marketing	14	MIT Sloan Management	1
Innovation You	3	Operation Management of Resources	1
Journal of Innovation	2	Organizational Studies	2
Business Journal	1	Organizational Dynamics	1

When a table is sourced, provide the source at the end of its caption. Tables should only be included after citation in the text. Additionally, all tables referenced in the text must be listed in the list of tables.

If the table is arranged horizontally, the Table 2.2 is an example of the format for a horizontal table.

Mathematical equations must be written by employing the equation editor in **MS WORD** and be numbered using Arabic numerals (Zulkernain et al., 2022). **Equation** or **Eq.** numbers must be written at the end of the equation and linked to the chapter

Table 2.2: Comparison between lab and simulation.

Length Ratio	Lab Experiment in Average	Comparison Simulation
0.250	0.46	0.560
0.375	0.63	0.738
0.500	0.75	0.861
0.625	0.83	0.939

number. For example, the numbers (Equation 2.1) and (Eq. 2.2) are given to the third and fourth equations respectively that appear in Chapter 2, as follows:

$$f(x) = a_0 + \sum_{n=1}^{\infty} \left(a_n \cos \frac{n\pi x}{L} + b_n \sin \frac{n\pi x}{L} \right) \quad (2.1)$$

Please refer to (Eq. 2.2)

$$\cos \alpha + \cos \beta = 2 \cos \frac{1}{2}(\alpha + \beta) \cos \frac{1}{2}(\alpha - \beta) \quad (2.2)$$

2.1.2.1 Heading 4

When a figure is sourced, provide the source at the end of its caption. The figure should only be included after the citation in the text. Additionally, all figures referenced in the text must be listed in the list of figures. If the figure is arranged horizontally, the following is an example of the format for a horizontal figure.

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2.3 Header 1

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2.4 Summary

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CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

3.2 Heading 2

3.2.1 Heading 3

3.2.1.1 Heading 4

3.3 Heading 2

3.3.1 Heading 2

3.3.1.1 Heading 2

3.4 Summary

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

4.2 Heading 2

4.2.1 Heading 3

4.2.2 Heading 4

4.3 Heading 2

4.3.1 Heading 3

4.3.1.1 Heading 4

4.4 Heading 2

4.4.1 Heading 4

4.5 Summary

CHAPTER 5

CONCLUSION AND FUTURE WORK

5.1 Introduction

5.2 Heading 2

5.2.1 Heading 3

5.2.2 Heading 4

5.2.3 Heading 4

5.3 Heading 2

5.3.1 Heading 3

5.3.1.1 Heading 4

5.4 Summary

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- [2] A. H. Abdi and H. Rasheed, "Performance analysis of outdoor massive mimo on ultra-high frequency bands (73 ghz and 100 ghz)," in *Proceedings of the International Symposium on Networks, Computers and Communications (ISNCC)*, 2022, pp. 1–6.
- [3] A. H. Abdi, L. Audah, A. Salh, M. A. Alhartomi, H. Rasheed, S. Ahmed, and A. Tahir, "Security control and data planes of sdn: A comprehensive review of traditional, ai, and mtd approaches to security solutions," *IEEE Access*, vol. 12, pp. 69 941–69 980, 2024.
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- [5] A. Hirsi, L. Audah, A. Salh, N. M. Sahar, S. Ahmed, and M. A. Alhartomi, "Ddos anomaly detection in software-defined networks: An evaluation of machine learning techniques for traffic classification and prediction," in *Proceedings of the International Conference on Future Technologies for Smart Society (ICFTSS)*, 2024, pp. 100–105.
- [6] A. Hirsi, L. Audah, A. Salh, N. M. Sahar, M. A. Alhartomi, and S. Ahmed, "Detecting low-rate ddos attacks in sdn using ensemble machine learning techniques," in *Proceedings of the IEEE 22nd Student Conference on Research and Development (SCORED)*, 2024, pp. 299–304.
- [7] A. Hirsi, L. Audah, A. Salh, M. A. Alhartomi, and S. Ahmed, "Detecting ddos threats using supervised machine learning for traffic classification in software defined networking," *IEEE Access*, vol. 12, pp. 166 675–166 702, 2024.
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- [10] A. Hirsi, L. Audah, A. Salh, M. Alhartomi, Z. Sun, A. Hammoodi, and S. Ahmed, “Artificial intelligence performance evaluation for urllc of industrial iot applications: A review, open challenges and future directions,” *Physical Communication*, p. 102712, 2025.
- [11] H. Liang, H. Liu, F. Dang, L. Yan, and D. Li, “Information system security protection based on sdn technology in cloud computing environment,” in *2021 IEEE International Conference on Advances in Electrical Engineering and Computer Applications (AEECA)*, 2021, pp. 432–435.

APPENDIX A: MININET CODE FOR SINGLE-PLANE DETECTION

This appendix contains the Mininet Python script used to emulate the single-plane DDoS detection topology shown in below code. The topology (see Algorithm F1) consists of three Open vSwitches, six hosts (four legitimate and two attacking), and one centralized controller running a machine learning-based detection logic. The controller is implemented externally using the Ryu framework.

Algorithm 1 Tool-Enhanced Reproducibility Workflow

- 1: Install Ubuntu 20.04 LTS as the base operating system.
 - 2: Install Python 3.9 using apt or pyenv.
 - 3: Install Mininet:
 - 4: `sudo apt install mininet`
 - 5: Clone and configure the Ryu controller:
 - 6: `git clone https://github.com/osrg/ryu.git`
 - 7: `cd ryu && python3 setup.py install`
 - 8: Install required Python packages:
 - 9: `pip install scikit-learn pandas numpy matplotlib seaborn`
 - 10: Define a custom SDN topology using Mininet (e.g., 1 controller, 3 switches, and 6 hosts).
 - 11: Start the Ryu controller:
 - 12: `ryu-manager ryu.app.simple_switch_13`
 - 13: Generate DDoS traffic using selected tools (e.g., SYN flood, UDP/ICMP flood).
 - 14: Modify the controller application to extract flow statistics.
 - 15: Save the flow statistics into CSV format (e.g., `flow_stats.csv`).
 - 16: Perform feature extraction and preprocessing for model training.
 - 17: Train and evaluate the proposed detection models using the prepared dataset.
-

PUBLICATION

1. **Abdinasir et al.**, “*HSF: A Hybrid SVM-RF Machine Learning Framework for Dual-Plane DDoS Detection and Mitigation in Software-Defined Networks*,” in *IEEE Access*, vol. 13, pp. 112303–112323, 2025, doi: 10.1109/ACCESS.2025.3583712. **(Q1 – IF: 3.6 – WoS)**
2. **Abdinasir et al.**, “*Detecting DDoS Threats Using Supervised Machine Learning for Traffic Classification in Software Defined Networking*,” in *IEEE Access*, vol. 12, pp. 166675–166702, 2024, doi: 10.1109/ACCESS.2024.3486034. **(Q1 – IF: 3.6 – WoS)**
3. **Abdinasir et al.**, “*Comprehensive Analysis of DDoS Anomaly Detection in Software-Defined Networks*,” in *IEEE Access*, vol. 13, pp. 69941–69980, 2025, doi: 10.1109/ACCESS.2025.3535943. **(Q1 – IF: 3.6 – WoS)**
4. **Abdinasir et al.**, “*Security Control and Data Planes of SDN: A Comprehensive Review of Traditional, AI, and MTD Approaches to Security Solutions*,” in *IEEE Access*, vol. 12, pp. 69941–69980, 2024, doi: 10.1109/ACCESS.2024.3393548. **(Q1 – IF: 3.6 – WoS)**
5. **Abdinasir et al.**, “*Artificial Intelligence Performance Evaluation for URLLC of Industrial IoT Applications: A Review, Open Challenges and Future Directions*,” in *Physical Communication*, 2025. **(Q2 – IF: 2.2 – WoS)**
6. **Abdinasir et al.**, “*Corrections to ‘Security Control and Data Planes of SDN: A Comprehensive Review of Traditional, AI, and MTD Approaches to Security Solutions’*,” in *IEEE Access*, vol. 12, pp. 162107–162108, 2024, doi: 10.1109/ACCESS.2024.3486825. **(Q1 – IF: 3.6 – WoS)**
7. **Abdinasir et al.**, “*Enhancing SDN Security Using Ensemble-Based Machine Learning Approach for DDoS Attack Detection*,” *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 38, no. 2, pp. 1073–1085, May 2025. ISSN 2502-4760. **(Q3 – Scopus Indexed)**

VITAE



Abdinasir Hirsi Abdi (**Member, IEEE: 97541484**) was born in Somalia. He received his B.S. degree in Telecommunication Engineering from MAJU University, Pakistan, in 2019. He later obtained his M.S. (Research) in Electrical Engineering from Bahria University, Pakistan, in 2021. Following his master's degree, he gained over two years of professional experience in network infrastructure, cybersecurity, and ICT, working with organizations such as Somtel Telecom, Somalia, and Pakistan Telecommunication Company Limited (PTCL), Pakistan. He is certified in cybersecurity and network systems by Cisco, Fortinet, and (ISC)². He also served as a lecturer at East Africa University (EAU), Somalia, where he taught undergraduate courses and supervised final-year projects in Telecommunication Engineering. In 2023, Abdinasir began his Ph.D. in Electrical Engineering at Universiti Tun Hussein Onn Malaysia (UTHM), under the supervision of Prof. Dr. Lukman Audah. He is currently a Graduate Research Assistant at the Advanced Telecommunication Research Center (ATRC), FKEE, UTHM. During his doctoral studies, he has authored more than 15 scholarly publications, including journal articles indexed in Web of Science and Scopus, as well as conference papers published by IEEE. His research interests include software-defined networking security, cybersecurity, artificial intelligence, DDoS detection and mitigation, and the application of machine learning and deep learning techniques in network intrusion detection.