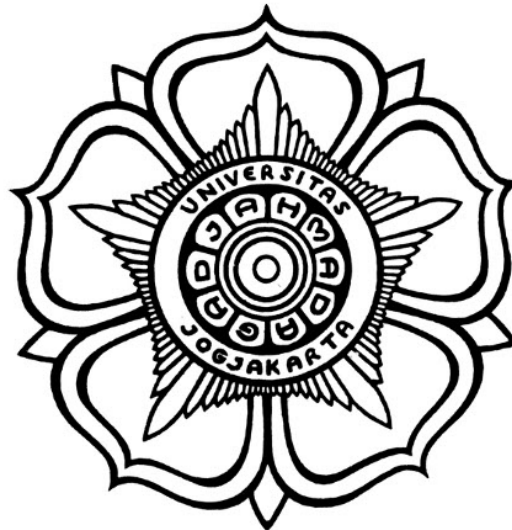


**TRANSFORMING UNIVERSITY MENTAL HEALTH SUPPORT:
AN AGENTIC AI FRAMEWORK FOR PROACTIVE
INTERVENTION AND RESOURCE MANAGEMENT**

SKRIPSI



**THE SUSTAINABLE DEVELOPMENT GOALS
Industry, Innovation and Infrastructure
Affordable and Clean Energy
Climate Action**

Written by:

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TEKNOLOGI INFORMASI PROGRAM

**DEPARTMENT OF ELECTRICAL ENGINEERING AND
INFORMATION TECHNOLOGY
FACULTY OF ENGINEERING UNIVERSITAS GADJAH MADA
YOGYAKARTA
2025**

ENDORSEMENT PAGE

TRANSFORMING UNIVERSITY MENTAL HEALTH SUPPORT: AN AGENTIC AI FRAMEWORK FOR PROACTIVE INTERVENTION AND RESOURCE MANAGEMENT

THESIS

Proposed as A Requirement to Obtain
Undergraduate Degree (*Sarjana Teknik*)
in Department of Electrical Engineering and Information Technology
Faculty of Engineering
Universitas Gadjah Mada

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PAGE OF DEDICATION

Tugas akhir ini kupersembahkan kepada kedua orang tuaku. Kupersembahkan pula kepada keluarga dan teman-teman semua, serta untuk bangsa, negara, dan agamaku.

[contoh]

PREFACE

Puji syukur ke hadirat Allah SWT atas limpahan rahmat, karunia, serta petunjuk-Nya sehingga tugas akhir berupa penyusunan skripsi ini telah terselesaikan dengan baik. Dalam hal penyusunan tugas akhir ini penulis telah banyak mendapatkan arahan, bantuan, serta dukungan dari berbagai pihak. Oleh karena itu pada kesempatan ini penulis mengucapkan terima kasih kepada:

1. <isi dengan nama Kadep>
2. <isi dengan nama Sekdep>
3. <isi dengan nama Dosen Pembimbing>
4. Kedua Orang Tua, kakak, dan adik yang selalu memberikan arahan selama belajar dan menyelesaikan tugas akhir ini.
5. <isi dengan nama orang lainnya>

Akhir kata penulis berharap semoga skripsi ini dapat memberikan manfaat bagi kita semua, aamiin. [Contoh]

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NOMENCLATURE AND ABBREVIATION

[SAMPLE]

b	=	bias
$K(x_i, x_j)$	=	fungsi kernel
y	=	kelas keluaran
C	=	parameter untuk mengendalikan besarnya pertukaran antara penalti variabel slack dengan ukuran margin
L_D	=	persamaan Lagrange dual
L_P	=	persamaan Lagrange primal
\mathbf{w}	=	vektor bobot
\mathbf{x}	=	vektor masukan
ANFIS	=	Adaptive Network Fuzzy Inference System
ANSI	=	American National Standards Institute
DAG	=	Directed Acyclic Graph
DDAG	=	Decision Directed Acyclic Graph
HIS	=	Hue Saturation Intensity
QP	=	Quadratic Programming
RBF	=	Radial Basis Function
RGB	=	Red Green Blue
SV	=	Support Vector
SVM	=	Support Vector Machines

INTISARI

Intisari ditulis menggunakan bahasa Indonesia dengan jarak antar baris 1 spasi dan maksimal 1 halaman. Intisari sekurang-kurangnya berisi tentang latar belakang dan tujuan penelitian, metodologi yang digunakan, hasil penelitian, kesimpulan dan implikasi, dan Kata kunci yang berhubungan dengan penelitian.

Kata Kunci ditulis maksimal 5 kata yang paling berhubungan dengan isi skripsi. Silakan mengacu pada ACM / IEEE *Computing classification* jika Anda adalah mahasiswa Sarjana TI <http://www.acm.org/about/class/> atau mengacu kepada IEEE keywords http://www.ieee.org/documents/taxonomy_v101.pdf jika Anda berasal dari Prodi Sarjana TE.

Kata kunci : Kata kunci 1, Kata kunci 2, Kata kunci 3, Kata kunci 4, Kata kunci 5

Contoh Abstrak Teknik Elektro:

"Penelitian ini bertujuan untuk mengembangkan sistem pengendalian suhu ruangan dengan menggunakan microcontroller. Metodologi yang digunakan adalah desain sirkuit, implementasi sistem pengendalian, dan pengujian performa. Hasil penelitian menunjukkan bahwa sistem pengendalian suhu ruangan yang dikembangkan mampu mengendalikan suhu ruangan dengan akurasi sebesar $\pm 0,5^{\circ}\text{C}$. Kesimpulan dari penelitian ini adalah sistem pengendalian suhu ruangan yang dikembangkan efektif dan efisien.

Kata kunci: microcontroller, sistem pengendalian suhu, akurasi."

Contoh Abstrak Teknik Biomedis:

"Penelitian ini bertujuan untuk mengevaluasi keefektifan prototipe alat pemantau denyut jantung berbasis elektrokardiogram (ECG) untuk pasien jantung. Metodologi yang digunakan meliputi desain dan pembuatan prototipe, pengujian dengan pasien, dan analisis data. Hasil penelitian menunjukkan bahwa prototipe alat pemantau denyut jantung berbasis ECG memiliki akurasi yang baik dan mampu memantau denyut jantung pasien secara efektif. Kesimpulan dari penelitian ini adalah prototipe alat pemantau denyut jantung berbasis ECG merupakan solusi yang efektif dan efisien untuk memantau pasien jantung.

Kata kunci: elektrokardiogram, alat pemantau denyut jantung, akurasi."

Contoh Abstrak Teknologi Informasi:

"Penelitian ini bertujuan untuk mengevaluasi keamanan dan privasi pengguna aplikasi media sosial terpopuler. Metodologi yang digunakan meliputi analisis kebijakan privasi dan pengaturan keamanan, pengujian penetrasi, dan survei pengguna. Hasil penelitian menunjukkan bahwa beberapa aplikasi media sosial memiliki kebijakan privasi yang kurang jelas dan rendahnya tingkat keamanan. Kesimpulan dari penelitian ini adalah pentingnya meningkatkan kebijakan privasi dan tingkat keamanan pada aplikasi media sosial untuk melindungi privasi dan data pengguna.

Kata kunci: media sosial, keamanan, privasi, pengguna."

ABSTRACT

*The provision of mental health support in Higher Education Institutions (HEIs) is often hampered by a reactive model, limited scalability, and inefficient resource allocation. This research addresses these challenges by proposing a novel agentic AI framework designed to enable a proactive, data-driven approach to student well-being. The framework is comprised of three collaborative agents: an **Analytics Agent** for trend identification, an **Intervention Agent** for automated outreach, and a **Triage Agent** for efficient resource routing.*

We designed and implemented a functional prototype of this framework utilizing a hybrid architecture that combines a locally-hosted Large Language Model (LLM) managed by LangChain within a FastAPI backend, orchestrated by the n8n workflow automation platform. The prototype's feasibility was validated through three testing scenarios demonstrating its capability to autonomously generate insight reports, manage intervention workflows, and perform initial triage. The results indicate that this agentic framework presents a viable pathway for transforming university mental health services, offering significant potential to improve operational efficiency and enable proactive, evidence-based decision-making.

Keywords : Keyword 1, Keyword 2, Keyword 3, Keyword 4, Keyword 5

CHAPTER I

INTRODUCTION

1.1 Background

Higher Education Institutions (HEIs) are facing a critical and growing challenge in supporting student well-being [1]. A landmark report highlights the escalating prevalence of mental health and substance use issues among student populations, urging institutions to adopt a more comprehensive support model [1]. This crisis not only jeopardizes students' academic success and personal development but also places an immense, unsustainable strain on the institutions tasked with supporting them [1].

The traditional support model, centered around on-campus counseling services, is fundamentally **reactive**. It relies on students to self-identify their distress and navigate the process of seeking help. This paradigm faces significant operational challenges, including insufficient staffing, long waiting lists, and an inability to provide immediate, 24/7 support, which ultimately limits access for a large portion of the student body [1]. Consequently, a critical gap persists between the need for mental health services and their actual provision, leaving many students without timely support [1].

To bridge this gap, a paradigm shift from a reactive to a **proactive** support model is imperative [1]. The engine for this evolution is **Digital Transformation**, a process that leverages technology to fundamentally reshape organizational processes and enhance value delivery within HEIs [1]. Within this context, Artificial Intelligence (AI) has emerged as a key enabling technology, with systematic reviews confirming its significant potential to analyze complex data, automate processes, and deliver personalized interventions at scale within the higher education landscape [1].

This research moves beyond conventional AI applications by proposing the use of **Agentic AI**. An intelligent agent is an autonomous system capable of perception, decision-making, and proactive action to achieve specific goals [1], representing a new frontier in educational technology [1]. We propose that a framework built upon a system of collaborative intelligent agents, a Multi-Agent System (MAS), a concept already explored for smart campus management [1], can create a truly transformative ecosystem. Such a system would not only serve as a support tool for students but, more importantly, would function as a strategic asset for the institution, enabling data-driven decision-making, automating operational workflows, and facilitating a proactive stance on student well-being. This thesis details the design, development, and evaluation of such a framework, prototyped within the UGM-AICare project.

1.2 Problem Formulation

The inefficiency and reactive nature of current university mental health support systems present a complex problem. This research addresses the following core challenges:

1. The primary challenge is the **design of an agentic AI framework** capable of automating key institutional processes, specifically in the areas of trend analysis, proactive intervention, and initial user triage.
2. A significant technical challenge lies in the **design and implementation of a robust, modular, and hybrid architecture** to realize this framework, requiring the integration of local Large Language Models (e.g., self-hosted Gemma 3), cloud-based models (e.g., Gemini through AI Studio), and workflow automation platforms (e.g., n8n).
3. Finally, there is a need to **evaluate the potential impact** of such a framework on institutional operational efficiency and data-driven decision-making, which will be validated through a proof-of-concept prototype and scenario-based testing.

1.3 Objectives

The primary objectives of this thesis are:

1. To design the conceptual and technical framework for the agentic AI system.
2. To implement a functional proof-of-concept prototype.
3. To evaluate the prototype's capabilities against predefined functional scenarios.

1.4 Scope and Limitations

To ensure the feasibility and focus of this research, the following boundaries are established:

1. This research is focused on the **design and prototype implementation** of the agentic AI framework, not a full-scale, university-wide deployment.
2. The evaluation of the framework is based on **functional, scenario-based testing** of the prototype's capabilities. It does not measure the long-term psychological impact on students or the real-world operational savings for the institution.
3. The data utilized for testing the analytics agent will consist of anonymized, pre-existing chat logs or simulated data to ensure user privacy and controlled testing conditions.
4. The research will not address the ethical implications of AI in education, such

as bias in AI algorithms or the potential for misuse of student data. These are acknowledged as important issues but are outside the scope of this thesis.

1.5 Contributions

1. Academic: A novel framework for applying agentic AI in an institutional (higher education) context.
2. Practical: A blueprint for UGM to develop a more proactive, data-driven, and efficient mental health support system.

1.6 Thesis Outline

The structure of this thesis is outlined as follows:

Chapter I: Introduction. This chapter elaborates on the background of the study, the justification for the research’s significance, the problem formulation to be addressed, and the specific objectives to be achieved. It also defines the scope and limitations of the research, outlines the expected contributions, and presents the overall organizational structure of the thesis report.

Chapter II: Literature Review and Theoretical Framework. This chapter presents a comprehensive review of relevant prior research in the fields of conversational AI, the application of gamification in educational and well-being contexts, related blockchain applications, and studies on user engagement and student welfare. Furthermore, this chapter establishes the theoretical foundation that underpins the core concepts and technologies utilized in this research.

Chapter III: System Design and Architecture. This chapter outlines the methodology and technical blueprint for the system. This chapter explains the adoption of Design Science Research and presents the system’s high-level conceptual architecture, including its core functional components. It details the underlying technical architecture, justifying the chosen technology stack, and describes the database structure. The chapter also covers the user interface design for system administration and specifies the integrated security and privacy measures.

Chapter IV: Implementation and Evaluation. This chapter describes the development and testing of the system prototype. This chapter details the technical environment used for implementation and demonstrates the functional prototype that was built. It then explains the testing process used to evaluate the system’s performance against its design requirements. The chapter concludes by presenting the results from these tests and providing an analysis of the findings.

Chapter V: Conclusion and Future Work. This chapter summarizes the study’s findings and contributions. This chapter revisits the initial research problems and presents

the main conclusions drawn from the research. It concludes by offering recommendations for both the future development of the system and for subsequent research in this area.

CHAPTER II

LITERATURE REVIEW AND THEORETICAL BACKGROUND

This chapter provides the theoretical foundations and academic context for the research. The first section, Theoretical Background, explains the core concepts and technologies that constitute the proposed framework. The second section, Literature Review, surveys existing work in related fields to identify the research gap that this thesis aims to address.

2.1 Theoretical Background

This section describes the foundational principles and technologies upon which the agentic AI framework is built, including Agentic AI, Large Language Models (LLMs), LLM orchestration, and workflow automation platforms.

2.1.1 Agentic AI and Multi-Agent Systems (MAS)

Artificial Intelligence (AI) has evolved beyond systems that perform simple classification or prediction tasks. A key advancement in this evolution is the concept of an **intelligent agent**. An agent is defined as an autonomous entity that perceives its environment through sensors and acts upon that environment through actuators to achieve specific goals [1]. The core characteristic of an agent is its autonomy; it can operate independently to make decisions and take actions without direct human intervention.

When multiple agents operate within the same environment and interact with one another, they form a **Multi-Agent System (MAS)** [1]. In an MAS, each agent typically has a specialized role and a set of goals. The overall system's intelligent behavior emerges from the collaboration, coordination, and negotiation among these individual agents. This thesis leverages the MAS paradigm by designing a framework composed of three specialized agents (Analytics, Intervention, and Triage), each with a distinct goal, that work collaboratively to achieve the overarching objective of proactive institutional support.

2.1.2 Large Language Models (LLMs)

Large Language Models (LLMs) are a class of deep learning models, most commonly based on the transformer architecture, that are trained on vast amounts of text data [1]. Their primary capability is to understand, generate, summarize, and translate human language with remarkable fluency. These models function by predicting the next word in a sequence, allowing them to perform a wide range of natural language processing (NLP) tasks.

This research utilizes a **hybrid LLM strategy** to balance performance, privacy, and capability:

- **Locally-Hosted Open Models (e.g., Gemma):** These are models with open weights that can be deployed on institutional hardware. The primary advantage is data privacy and control, as sensitive data does not need to be sent to third-party vendors. They also offer low latency, which is crucial for real-time applications like the Triage Agent [1].
- **Cloud-Based API Models (e.g., Gemini):** These are state-of-the-art, proprietary models accessed via an API. They often provide superior performance on highly complex tasks. In this framework, such a model is used as a robust fallback mechanism to ensure service continuity if the local model fails, thereby enhancing system reliability [1].

2.1.3 LLM Orchestration Frameworks (LangChain)

An LLM, in isolation, is a powerful text processor but lacks the ability to perform complex, multi-step tasks or interact with external systems. This limitation is addressed by LLM orchestration frameworks like **LangChain** [1]. LangChain is a software development framework that provides modular components for building applications powered by LLMs.

Key components of LangChain utilized in this research include:

- **Chains:** Sequences of calls, either to an LLM or another utility, that allow for complex, multi-step logic.
- **Agents and Tools:** LangChain allows the creation of agents that use an LLM as a reasoning engine to decide which "tools" to use. A tool can be any function, such as a database query, a calculation, or an API call.
- **Retrieval-Augmented Generation (RAG):** This technique allows an LLM to access and incorporate information from external knowledge bases before generating a response, which is crucial for providing context-aware answers.

In this thesis, LangChain serves as the core of the "Brain" within the FastAPI backend, enabling the development of the sophisticated logic required by the three agents.

2.1.4 Workflow Automation Platforms (n8n)

Modern software systems rarely exist in isolation. The ability to integrate disparate systems and automate data flows is critical for operational efficiency. **Workflow Automation Platforms** are designed for this purpose [1]. These platforms provide a visual interface to connect various applications, databases, and APIs into automated sequences, or "workflows."

This project utilizes **n8n**, an open-source workflow automation tool. Unlike a general-purpose programming language, n8n excels at tasks involving scheduling, event triggers, and system-to-system communication. In our architecture, n8n functions as the "Nervous System," responsible for:

- ****Scheduled Triggers:**** Running tasks at specific times (e.g., triggering the Analytics Agent every Sunday via a Cron job).
- ****API Integration:**** Calling the API endpoints exposed by our FastAPI backend and communicating with external services (e.g., an email server).
- ****Visual Workflow Management:**** Providing a clear, visual representation of the automated processes, which simplifies debugging and modification.

2.2 Literature Review

Bagian ini memaparkan landasan konseptual dan teoritis yang relevan dengan komponen-komponen utama platform yang diusulkan. Pemahaman mendalam terhadap teori ini esensial untuk perancangan sistem yang efektif dan evaluasi yang valid. Sumber utama bagian ini adalah buku referensi, artikel tinjauan (*review articles*), dan publikasi ilmiah fundamental di bidang terkait.

2.2.1 AI Konversasional Hibrida (*Hybrid Conversational AI*)

Survey existing research on AI applications in university administration and management.

2.2.2 Gamifikasi dan Teori Motivasi

Review papers on Decision Support Systems (DSS) and Business Process Automation (BPA) in other industries.

2.2.3 Teknologi Blockchain dan Aplikasinya yang Relevan

Analyze existing systems for student support or mental health, highlighting their limitations (e.g., most are purely reactive chatbots).

2.2.4 Keterlibatan Pengguna (*User Engagement*) dan Kesejahteraan Mahasiswa (*Student Well-being*) dalam Konteks Digital

Conclude by identifying the research gap: the lack of a proactive, multi-agent framework for transforming the process of mental health support at an institutional level.

2.3 Analisis Perbandingan Metode

Di dalam tinjauan pustaka hasil akhirnya adalah analisis secara kualitatif atau pun secara kuantitatif kelebihan dan kekurangan metode jika dikaitkan dengan masalah, batasan-batasan masalah dan solusi yang diinginkan. Analisis kuantitatif tidak wajib tetapi mempunyai nilai tambah di dalam tugas akhir saudara. Bagian ini menjelaskan kenapa metode tersebut dipilih dan uraikan dengan lebih jelas metode pelaksanaan tugas akhir yang ingin Anda lakukan.

2.4 Pertanyaan Tugas Akhir (Jika Perlu)

Pertanyaan tugas akhir bersifat opsional dan dapat ditambahkan untuk menekankan hal-hal yang hendak diketahui dari tugas akhir berdasar pada tujuan tugas akhir. Pertanyaan tugas akhir dikenal dengan RQ (*Research Question*) dan harus memiliki keterkaitan dengan RO (*Research Objective*). Satu RO dapat memiliki satu atau lebih dari satu RQ.

CHAPTER III

METODE PENELITIAN

3.1 Research Methodology: Design Science Research (DSR)

3.2 System Overview and Conceptual Design

Purpose: To provide a high-level, 10,000-foot view of the system's purpose and its main components, making it understandable before diving into technical specifics.

Elaboration Points:

Present a concise paragraph describing the conceptual model: "The proposed framework is an ecosystem of three collaborative, intelligent agents that work in concert to transform an institution's mental health support from a reactive to a proactive model..."

Include a high-level Context Diagram showing the main entities (Students, University Staff/Counselors) and systems (UGM-AICare User App, Agentic AI Backend, Admin Dashboard) and how they interact.

3.3 Functional Architecture: The Agentic Core

Purpose: To detail the "what" of the system. This section explains the specific roles and functions of each agent. This is the heart of your functional design.

Elaboration Points: Create a subsection for each of the three agents. For each, define its:

3.3.1 The Analytics Agent

Goal: To autonomously identify mental health trends from anonymized user data.

Perception (Inputs): Anonymized conversation logs from the PostgreSQL database.

Processing Logic: Describe the NLP tasks it performs: topic modeling, sentiment analysis, and summarization.

Action (Outputs): A structured weekly report (in JSON format) containing key insights (e.g., top 5 trending stress topics, overall sentiment score).

3.3.2 The Intervention Agent

Goal: To automate targeted, proactive outreach campaigns.

Perception (Inputs): The structured report from the Analytics Agent and a set of predefined "campaign rules."

Processing Logic: A rule-based engine that maps insights to actions (e.g., IF 'exam stress' > threshold THEN trigger 'time-management-workshop' campaign).

Action (Outputs): A signal sent to the orchestration layer (n8n) with target audience segment and message content.

3.3.3 The Triage Agent

Goal: To efficiently route a student to the most appropriate level of support in real-time.

Perception (Inputs): A user's live conversation with the chatbot.

Processing Logic: A real-time text classification model to determine the conversation's severity level (e.g., Level 1: Casual, Level 2: Moderate, Level 3: Red Flag).

Action (Outputs): A structured recommendation (e.g., suggest a self-help module, suggest booking a counselor, provide an emergency hotline).

Include a detailed Data Flow Diagram (DFD) showing how data moves between these three agents and the database.

3.4 Technical Architecture: The Hybrid System

Purpose: To detail the "how" of the system—the engineering blueprint, including justification for key technology choices.

Elaboration Points:

3.4.1 Overall System Architecture Diagram

A detailed diagram showing the interplay between all technologies: Next.js (Admin Dashboard), FastAPI (Backend), PostgreSQL, LangChain (as a library), and n8n (as a separate, orchestrated service). Show the communication protocols (e.g., REST API, direct DB connection).

3.4.2 The "Brain": FastAPI + LangChain Service

Justify the choice of FastAPI (for performance, async support) and LangChain (for LLM orchestration). Detail the API design, defining key endpoints (e.g., /api/agents/generate-report) and their request/response schemas.

3.4.3 The "Nervous System": n8n Workflows

Justify the choice of n8n for robust workflow automation. Provide screenshots or diagrams of the primary n8n workflows (e.g., the "Weekly Report Generation" workflow triggered by a Cron job).

3.5 Database Design

Purpose: To define the data persistence layer of the system.

Elaboration Points:

Present a clean Entity-Relationship Diagram (ERD).

Table 3.1. Key Columns and Data Types for conversation_logs Table

Column Name	Data Type	Description
id	SERIAL PRIMARY KEY	Unique identifier
user_id	UUID	Reference to user (anonymized)
timestamp	TIMESTAMP WITH TIME ZONE	Time of message
message	TEXT	User or agent message content
sender	VARCHAR(16)	'user' or 'agent'
sentiment_score	FLOAT	Sentiment analysis result
topic	VARCHAR(64)	NLP-inferred topic label

3.6 User Interface (UI) Design

Purpose: To show the design of the human interface for the system’s administrative users.

Elaboration Points:

Define the primary user persona for the dashboard (e.g., "Dr. Astuti, Head of Counseling Services").

Present wireframes or high-fidelity mockups for the key screens of the Admin Dashboard (e.g., the main analytics view, the report history page).

3.7 Security and Privacy by Design

Purpose: To demonstrate that critical security and privacy considerations are integral to the architecture.

Elaboration Points:

Detail the Data Anonymization Pipeline: How is Personally Identifiable Information (PII) identified and redacted from chat logs before they are stored for analysis?

Describe the Role-Based Access Control (RBAC) mechanism for the admin dashboard.

Mention standard security practices like data encryption in transit (TLS) and at rest.

3.8 Alur Tugas Akhir

Menguraikan prosedur yang akan digunakan dan jadwal atau alur penyelesaian setiap tahap. Alur penelitian ini dapat disajikan dalam bentuk diagram. Diagram dapat disusun dengan aturan yang baik semisal menggunakan *flowchart*. Aturan dan tutorial pembuatan *flowchart* dapat dilihat di <http://ugm.id/flowcharttutorial>. Setelah menggambarkannya, penulis wajib menjelaskan langkah-langkah setiap alur tugas akhir dalam sub bab tersendiri sesuai dengan kebutuhan.

3.9 Etika, Masalah, dan Keterbatasan Penelitian (Opsional)

Bagian ini membahas pertimbangan etis penelitian dan [potensi] masalah serta keterbatasannya. Jika menyangkut penelitian dengan makhluk hidup, maka dibutuhkan adanya *ethical clearance*, di bagian ini hal itu akan dibahas. Demikian juga tentang keterbatasan ataupun masalah yang akan timbul.

CHAPTER IV

HASIL DAN PEMBAHASAN

4.1 Pembahasan Hasil 1 (Ubah Judul Sesuai dengan Hal yang Hendak dibahas)

Poin pertama adalah membahas tujuan penelitian pertama. Dapat ditambahkan beberapa sub bab jika diperlukan.

4.2 Pembahasan Hasil 2 (Ubah Judul Sesuai dengan Hal yang Hendak dibahas)

Poin kedua adalah membahas tujuan penelitian kedua. Dapat ditambahkan beberapa sub bab jika diperlukan. Dapat juga diteruskan ke Sub Bab Pembahasan hasil 3 dan seterusnya, jika ada tiga atau lebih tujuan penelitian.

4.3 Perbandingan Hasil Penelitian dengan Hasil Terdahulu

Pembahasan penutup dapat menjelaskan mengenai kelebihan hasil pengembangan / penelitian dan kekurangan dibandingkan dengan skripsi atau penelitian terdahulu atau perbandingan terhadap produk lain yang ada di pasaran. Penulis dapat menggunakan tabel untuk membandingkan secara gamblang dan menjelaskannya.

CHAPTER V

TAMBAHAN (OPSIONAL)

Anda boleh menambahkan Bab jika diperlukan. Jumlah Bab tidak harus sesuai dengan *template*.

CHAPTER VI

KESIMPULAN DAN SARAN

6.1 Kesimpulan

Kesimpulan dapat diawali dengan apa yang dilakukan dengan tugas akhir ini lalu dilanjutkan dengan poin-poin yang menjawab tujuan penelitian, apakah tujuan sudah tercapai atau belum, tentunya berdasarkan data ataupun hasil dari Bab pembahasan sebelumnya. Dalam beberapa hal, kesimpulan dapat juga berisi tentang temuan/*findings* yang Anda dapatkan setelah melakukan pengamatan dan atau analisis terhadap hasil penelitian.

6.2 Saran

Saran berisi hal-hal yang bisa dilanjutkan dari penelitian atau skripsi ini, yang belum dilakukan karena batasan permasalahan. Saran bukan berisi saran kepada sistem atau pengguna, tetapi saran diberikan kepada aspek penelitian yang dapat dikembangkan dan ditambahkan di penelitian atau skripsi selanjutnya.

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Catatan: Daftar pustaka adalah apa yang dirujuk atau disitasi, bukan apa yang telah dibaca, jika tidak ada dalam sitasi maka tidak perlu dituliskan dalam daftar pustaka.

LAMPIRAN

L.1 Isi Lampiran

Lampiran bersifat opsional bergantung hasil kesepakatan dengan pembimbing dapat berupa:

1. Bukti pelaksanaan Kuesioner seperti pertanyaan kuesioner, resume jawaban responden, dan dokumentasi kuesioner.
2. Spesifikasi Aplikasi atau Sistem yang dikembangkan meliputi spesifikasi teknis aplikasi, tautan unduh aplikasi, manual penggunaan aplikasi, hingga screenshot aplikasi.
3. Cuplikan kode yang sekiranya penting dan ditambahkan.
4. Tabel yang terlalu panjang yang masih diperlukan tetapi tidak memungkinkan untuk ditayangkan di bagian utama skripsi.
5. Gambar-gambar pendukung yang tidak terlalu penting untuk ditampilkan di bagian utama. Akan tetapi, mendukung argumentasi/pengamatan/analisis.
6. Penurunan rumus-rumus atau pembuktian suatu teorema yang terlalu panjang dan terlalu teknis sehingga Anda berasumsi bahwa pembaca biasa tidak akan menelaah lebih lanjut. Hal ini digunakan untuk memberikan kesempatan bagi pembaca tingkat lanjut untuk melihat proses penurunan rumus-rumus ini.

LAMPIRAN

L.2 Panduan Latex

L.2.1 Syntax Dasar

L.2.1.1 Penggunaan Sitasi

Contoh penggunaan sitasi [2, 3] [4] [5] [6] [7, 8]

L.2.1.2 Penulisan Gambar

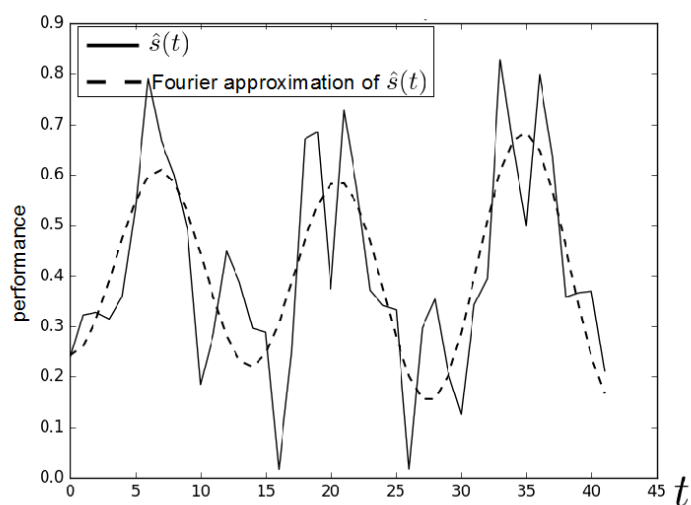


Figure 1. Contoh gambar.

Contoh gambar terlihat pada Gambar 1. Gambar diambil dari [8].

L.2.1.3 Penulisan Tabel

Table 1. Tabel ini

ID	Tinggi Badan (cm)	Berat Badan (kg)
A23	173	62
A25	185	78
A10	162	70

Contoh penulisan tabel bisa dilihat pada Tabel 1.

L.2.1.4 Penulisan formula

Contoh penulisan formula

$$L_{\psi_z} = \{t_i \mid v_z(t_i) \leq \psi_z\} \quad (1)$$

Contoh penulisan secara *inline*: $PV = nRT$. Untuk kasus-kasus tertentu, kita membutuhkan perintah "mathit" dalam penulisan formula untuk menghindari adanya jeda saat penulisan formula.

Contoh formula **tanpa** menggunakan "mathit": $PVA = RTD$

Contoh formula **dengan** menggunakan "mathit": $PVA = RTD$

L.2.1.5 Contoh list

Berikut contoh penggunaan list

1. First item
2. Second item
3. Third item

L.2.2 Blok Beda Halaman

L.2.2.1 Membuat algoritma terpisah

Untuk membuat algoritma terpisah seperti pada contoh berikut, kita dapat memanfaatkan perintah *algstore* dan *algrestore* yang terdapat pada paket *algcompatible*. Pada dasarnya, kita membuat dua blok algoritma dimana blok pertama kita simpan menggunakan *algstore* dan kemudian di-restore menggunakan *algrestore* pada algoritma kedua. Perintah tersebut dimaksudkan agar terdapat kesinamungan antara kedua blok yang sejatinya adalah satu blok.

Algorithm 1 Contoh algorima

```
1: procedure CREATESET( $v$ )  
2:   Create new set containing  $v$   
3: end procedure
```

Pada blok algoritma kedua, tidak perlu ditambahkan caption dan label, karena sudah menjadi satu bagian dalam blok pertama. Pembagian algoritma menjadi dua bagian ini berguna jika kita ingin menjelaskan bagian-bagian dari sebuah algoritma, maupun untuk memisah algoritma panjang dalam beberapa halaman.

```
4: procedure CONCATSET( $v$ )  
5:   Create new set containing  $v$   
6: end procedure
```

L.2.2.2 Membuat tabel terpisah

Untuk membuat tabel panjang yang melebihi satu halaman, kita dapat mengganti kombinasi *table* + *tabular* menjadi *longtable* dengan contoh sebagai berikut.

Table 2. Contoh tabel panjang

header 1	header 2
foo	bar
foo	bar
foo	bar
foo	bar
foo	bar
foo	bar
foo	bar
foo	bar
foo	bar
foo	bar
foo	bar
foo	bar

L.2.2.3 Menulis formula terpisah halaman

Terkadang kita butuh untuk menuliskan rangkaian formula dalam jumlah besar sehingga melewati batas satu halaman. Solusi yang digunakan bisa saja dengan memindahkan satu blok formula tersebut pada halaman yang baru atau memisah rangkaian formula menjadi dua bagian untuk masing-masing halaman. Cara yang pertama mungkin akan menghasilkan alur yang berbeda karena ruang kosong pada halaman pertama akan diisi oleh teks selanjutnya. Sehingga di sini kita dapat memanfaatkan *align* yang sudah diatur dengan mode *allowdisplaybreaks*. Penggunaan *align* ini memungkinkan satu rangkaian formula terpisah berbeda halaman.

Contoh sederhana dapat digambarkan sebagai berikut.

$$\begin{aligned}
 x &= y^2 \\
 x &= y^3 \\
 a + b &= c \\
 x &= y - 2 \\
 a + b &= d + e \\
 x^2 + 3 &= y \\
 a(x) &= 2x
 \end{aligned}
 \tag{2}$$

$$b_i = 5x$$

$$10x^2 = 9x$$

$$2x^2 + 3x + 2 = 0$$

$$5x - 2 = 0$$

$$d = \log x$$

$$y = \sin x$$

LAMPIRAN

L.3 Format Penulisan Referensi

Penulisan referensi mengikuti aturan standar yang sudah ditentukan. Untuk internasionalisasi DTETI, maka penulisan referensi akan mengikuti standar yang ditetapkan oleh IEEE (*International Electronics and Electrical Engineers*). Aturan penulisan ini bisa diunduh di <http://www.ieee.org/documents/ieeecitationref.pdf>. Gunakan Mendeley sebagai *reference manager* dan *export* data ke format Bibtex untuk digunakan di Latex.

Berikut ini adalah sampel penulisan dalam format IEEE:

L.3.1 Book

Basic Format:

- [1] J. K. Author, "Title of chapter in the book," in Title of His Published Book, xth ed. City of Publisher, Country: Abbrev. of Publisher, year, ch. x, sec. x, pp. xxx-xxx.

Examples:

- [1] B. Klaus and P. Horn, Robot Vision. Cambridge, MA: MIT Press, 1986.
- [2] L. Stein, "Random patterns," in Computers and You, J. S. Brake, Ed. New York: Wiley, 1994, pp. 55-70.
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Polymers of Hexadromicon, J. Peters, Ed., 2nd ed. New York: McGraw-Hill, 1964, pp. 15-64.

L.3.2 Handbook

Basic Format:

- [1] Name of Manual/Handbook, x ed., Abbrev. Name of Co., City of Co., Abbrev. State, year, pp. xx-xx.

Examples:

- [1] Transmission Systems for Communications, 3rd ed., Western Electric Co., Winston Salem, NC, 1985, pp. 44-60.
- [2] Motorola Semiconductor Data Manual, Motorola Semiconductor Products Inc., Phoenix, AZ, 1989.
- [3] RCA Receiving Tube Manual, Radio Corp. of America, Electronic Components and Devices, Harrison, NJ, Tech. Ser. RC-23, 1992.

Conference/Prosiding

Basic Format:

- [1] J. K. Author, "Title of paper," in Unabbreviated Name of Conf., City of Conf., Abbrev. State (if given), year, pp.xxx-xxx.

Examples:

- [1] J. K. Author [two authors: J. K. Author and A. N. Writer] [three or more authors: J. K. Author et al.], "Title of Article," in [Title of Conf. Record as], [copyright year] © [IEEE or applicable copyright holder of the Conference Record]. doi: [DOI number]

Sumber Online/Internet

Basic Format:

- [1] J. K. Author. (year, month day). Title (edition) [Type of medium]. Available: [http://www.\(URL\)](http://www.(URL))

Examples:

- [1] J. Jones. (1991, May 10). Networks (2nd ed.) [Online]. Available: <http://www.atm.com>

Skripsi, Tesis dan Disertasi

Basic Format:

- [1] J. K. Author, "Title of thesis," M.S. thesis, Abbrev. Dept., Abbrev. Univ., City of Univ., Abbrev. State, year.

[2] J. K. Author, "Title of dissertation," Ph.D. dissertation, Abbrev. Dept., Abbrev. Univ., City of Univ., Abbrev. State, year.

Examples:

[1] J. O. Williams, "Narrow-band analyzer," Ph.D. dissertation, Dept. Elect. Eng., Harvard Univ., Cambridge, MA, 1993. [2] N. Kawasaki, "Parametric study of thermal and chemical nonequilibrium nozzle flow," M.S. thesis, Dept. Electron. Eng., Osaka Univ., Osaka, Japan, 1993

LAMPIRAN

L.4 Contoh Source Code

L.4.1 Sample algorithm

Algorithm 2 Kruskal's Algorithm

```
1: procedure MAKESET( $v$ )
2:   Create new set containing  $v$ 
3: end procedure
4:
5: function FINDSET( $v$ )
6:   return a set containing  $v$ 
7: end function
8:
9: procedure UNION( $u, v$ )
10:  Unites the set that contain  $u$  and  $v$  into a new set
11: end procedure
12:
13: function KRUSKAL( $V, E, w$ )
14:   $A \leftarrow \{\}$ 
15:  for each vertex  $v$  in  $V$  do
16:    MakeSet( $v$ )
17:  end for
18:  Arrange  $E$  in increasing costs, ordered by  $w$ 
19:  for each  $(u, v)$  taken from the sorted list do
20:    if FindSet( $u$ )  $\neq$  FindSet( $v$ ) then
21:       $A \leftarrow A \cup \{(u, v)\}$ 
22:      Union( $u, v$ )
23:    end if
24:  end for
25:  return  $A$ 
26: end function
```

L.4.2 Sample Python code

```
1 import numpy as np
2
3 def incmatrix (genl1 , genl2):
4     m = len (genl1)
5     n = len (genl2)
6     M = None #to become the incidence matrix
7     VT = np.zeros ((n*m,1) , int) #dummy variable
8
9     #compute the bitwise xor matrix
10    M1 = bitxormatrix (genl1)
11    M2 = np.triu (bitxormatrix (genl2) ,1)
12
13    for i in range (m-1):
14        for j in range (i+1, m):
15            [r,c] = np.where (M2 == M1[i , j])
16            for k in range (len (r)):
17                VT[(i)*n + r[k]] = 1;
18                VT[(i)*n + c[k]] = 1;
19                VT[(j)*n + r[k]] = 1;
20                VT[(j)*n + c[k]] = 1;
21
22    if M is None:
23        M = np.copy (VT)
24    else:
25        M = np.concatenate ((M, VT) , 1)
26
27    VT = np.zeros ((n*m,1) , int)
28
29    return M
```

L.4.3 Sample Matlab code

```
1 function X = BitXorMatrix(A,B)
2 %function to compute the sum without charge of two vectors
3
4 %convert elements into unsigned integers
5 A = uint8(A);
6 B = uint8(B);
7
8 m1 = length(A);
9 m2 = length(B);
10 X = uint8(zeros(m1, m2));
11 for n1=1:m1
12     for n2=1:m2
13         X(n1, n2) = bitxor(A(n1), B(n2));
14     end
15 end
```