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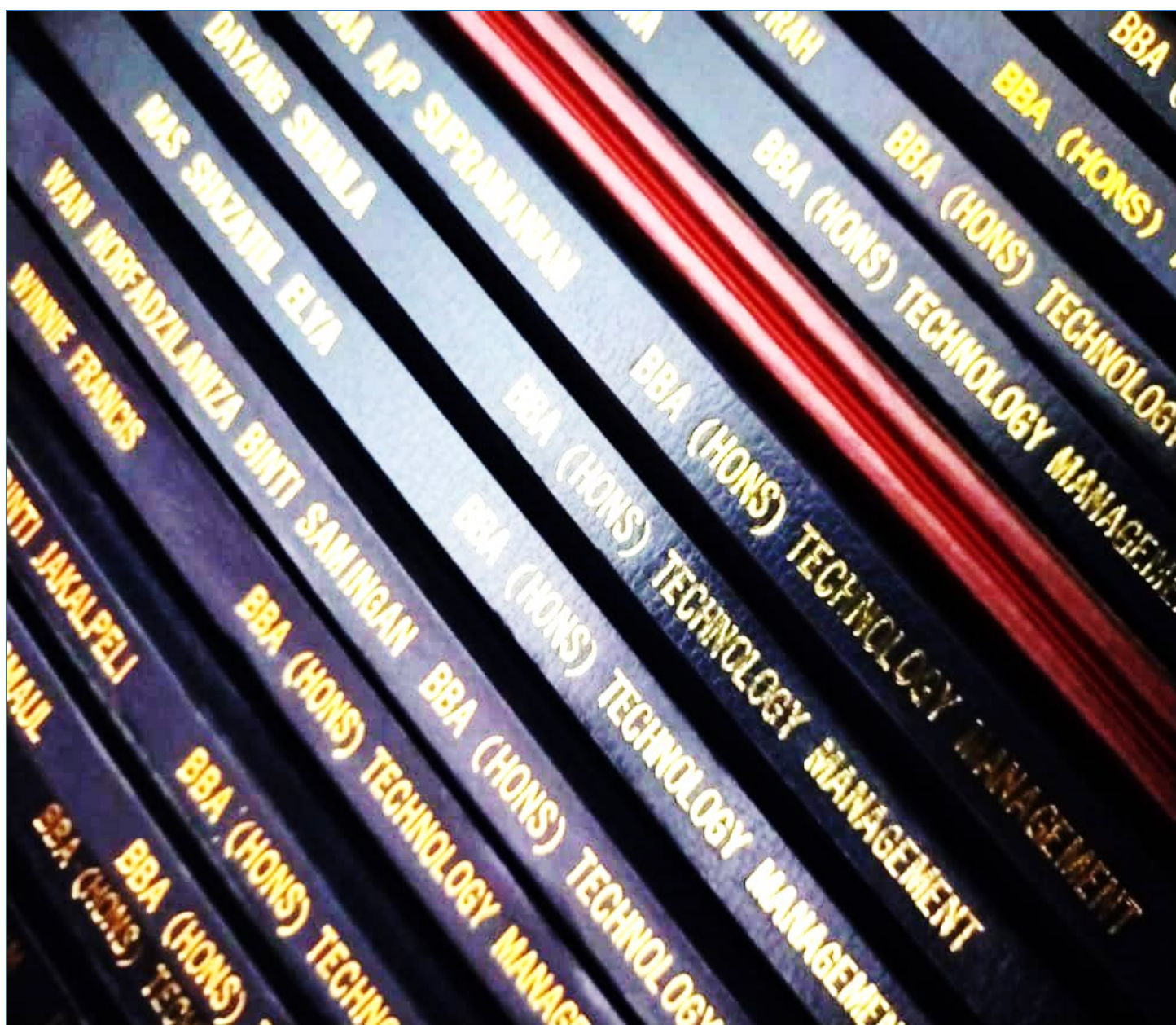
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Mapping the Customer Lifetime Value of KR1M in Malaysia: A Suitability Study of GIS Open Sources

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Abstract

Traditionally, the lifetime value of business including *Kedai Rakyat 1Malaysia* (KR1M) was measured by non-spatial model since the first model was introduced in early 1930s. The fundamental of establishment of customer lifetime value (CLV) model is to determine how long the business can be survived as well as determine the sustainability of the business. Based on current literature review, the CLV method, approach and model is dominating by non-spatial measurement, that makes spatial measurement is out-of context. The main objective of the study is to review the suitability of GIS open source for mapping the CLV of KR1M purposely to estimate the sustainability of KR1M. The comparisons are based on feature, tools and capability/platform, specifically with regard to task for mapping the CLV in spatial environment setting. The method used in this study was exploration study by testing and evaluating the performance of the eight (8) GIS open sources such as Quantum GIS, PostGIS, GeoServer and MapServer, OpenLayers and Leaflet, GDAL/OGR, Pythonic Spatial Libraries, GeoNode and MapStore, and Cloud-Native GIS Tools. The major finding is found that Cloud-Native GIS is the most preferred choices for mapping the CLV of KR1M, with reasonable arguments. In addition, this study will help the policy makers, government agency, and researcher in visualized the sustainability of KR1M in real marketplace, accordingly to spatial perspective.

Keywords : *Kedai Rakyat 1Malaysia (KR1M); Customer Lifetime Value; GIS Open Source*

I. INTRODUCTION

Historically, the first espoused in the 1930s, the Customer Lifetime Value (CLV) model was originally designed to assess the net present value of a customer's future spending. The father of Database Marketing that is Arthur M. Hughes introduced database approach for managing the customer relationship, formerly using financial-based instruments and model. After that, CLV is in widespread use among almost all small, medium and large firms in the marketing field in every sectors of business. There are three generic strategies for increasing CLV including (a) increase customer spending rate; (b) increase customer retention rate; and (c) increase customer referral rate [1]. Furthermore, the CLV research stream is aims at developing and maintaining profitable business relationships with selected profitable customers.

Continuously, the change of CLV in the marketplace as a traditional unpredictable issues to the firm, where each decade of years 1980s, 1990s and 2000s has dominated by unique major phenomenon. The CLV of shopping habits of consumers in the 1970s and 1980s were highly influenced by the brand of the product, compared to consumers today that are less likely to purchase a specific brand or patronize a particular company simply because the brands are well-known [2]. Empirically, the percentage of consumers who claim that they tend to stick with well-known brands when purchasing products and services has dropped dramatically for all age groups, in between of 1975 and 2000. Even the percentage for individuals over 60 years old – typically among the most brand-loyal consumers – dropped 20 points in the past 25 years. The study by Lipke is related to [3] and Rosenfield [4] where CLV in the 1980s and 1990s are stimulus

by firms and then, influenced customer shopping activity in the marketplaces.

Recent study about CLV in the same area are related to work from [5], [6], [7], [8], [9], [10], and [11]. Most of researchers pointed that CLV is main standard for measures the sustainability of the business, including the KR1M and related small retailers.

II. LITERATURE REVIEW

Theoretically, the CLV concept is extensively changing the way today's customer is managed as well as CLV as the foundation of customer profitability as noted by [12]. By understanding CLV, practically, it provides the best way to gain the competitive edge and reshaping the way the business manage with final aim to maximize their profitability and growth [13]. In advance, some researchers like [14], [15], and [16] believed CLV need to be revised and re-conceptualized, as implication of new challenge that exist in the marketplace. Recently, scholars such as [17], [18], and [19] also premise the same way of thinking where the CLV valuation needs to consider previous and current information of customers in the marketplace. Therefore, the CLV model and approach need to be redefined and reformulated to make it more suitable, according to the current unpredictable marketplaces of the business, as cordially of the unsolved issues of CLV and profitability as arisen in between of the relationship of customer-business.

Managing the customer lifetime value (CLV) is the top one initiative to ensure the sustainability of firms' profitability, both short and long term of performances, as mentioned in [20], [21], and [22]. It is critical to understand and sustain the CLV as well as business profitability, where it is important to a lifetime of business survival, as mentioned in [23] and [24]. [25] noted that to maximise long-term returns of the company, customer's value must be managed so as to move in the same direction as customer profitability. Essentially, this requires information on which of customers are most profitable to firm, how to satisfy their needs, how the firm acquire and retain their profitable customers, and how firm convert less profitable customers or cease trading with them. In addition, [26] have discussed some issues on profitability which included how the business can best serve the customers while retaining fair profits; how the business stand out in a highly competitive

environment where consumers have so many choices; and how the business grow up their business while retaining a core of loyal customers. Thereby, customer is a source of CLV and profitability where they have power to revolutionize their relationships to the business [27] and because of consequences of consumers intensely value-oriented, even more than in the recent past [28].

Strategically, valuing customers is a central issue of any commercial activity. The value of an individual customer is important for the detection of the most valuable ones, which deserve to be closely followed, and for the detection of the less valuable ones, to which the company should pay less attention [29]. Currently, [30] stressed that customer valuation is a crucial step for the business where CLV traditionally used for it evaluation. Meanwhile, Mark [31] thereby noted the CLV is a gold standard of customer profitability that is useable to increase the business performance. By sharing the same point of view, [32] believed that establishing relationship with customer is important to increase their revenues. This is supported by [33] where he suggest that the customer profitability must be evaluated for each of the customers where the value lies in the ability to see change over time; indeed, that may be the only value as it becomes a replicable measurement of consistently improving profitability created from increasingly better decisions. With regard to these scholars, business must regularly evaluate their customers with the finale aim to identify their best customers, who's potentially contributes profitable CLV to their business lifetime value.

There are some issues highlighted in context of CLV and Geospatial Information System (GIS) potential uses, specifically refer to Kedai Rakyat 1Malaysia (KR1M). An important view on problems, research gaps, and prospects are identified and discussed, as followed:

A. Limited Capability of CLV Approach

Since the CLV has been introduced to the field in the 1930s especially on marketing/retailing research, a multitude of CLV approaches have emerged, with variation in definitions, terms, and analogies. Specifically, there are two main streams of theoretical differentiable approaches for CLV, identified as CLV from a company perspective and CLV from a customer's perspective. However, both approaches have limitations on capability that been used for estimating the profitability of non-profit business such as Kedai Rakyat 1Malaysia (KR1M).

CLV in context of company, the CLV is assumed as central activity for the business with mainly objectives is to evaluate how attractive individual customers or customer groups are from a company's perspective, such as [34], [35], [36], and [37]. Meanwhile, CLV in context of customer has focused on value generated on a company's product or service as perceived by the customer or the fulfilment of customer goals and desires by company products and/or services, as mention in [38]. In addition, [39] state that there are too many marketing managers either fail to identify the most valuable customers or spending their marketing budget on the wrong customers. One of the problems is the CLV approach is backward looking and do not provide a future picture of customer's profitability. On contrary, [40] criticized this method, since a long life-cycle and the profitability of a customer were not necessarily related.

The existing of two major approaches actually will create the dual nature of CLV. According to [41], practically, the gaps are arising from these two approaches, and finally, generated vertical gap (internal gap) and horizontal gap (information, communication and perceived value gaps). Because of dual customer value model was developed based on a broad view of customer values, the decrease of some gaps (internal gaps) and the increase of other gaps (perceived gaps) in any model will enable companies to provide customers with the value desired by the customers.

With regard to the work as mention above, new approaches should be introduced to bridge the current gaps, as well as aiming to reduce the variations of the CLV results. In fact, the variations between these gaps cannot be standardized, or integrated into one platform until the new approach is established to the market. Critically, these gaps are expected to become more diverse in the future of prospecting the CLV, as well as profitability KRIM will be more difficult to predict.

B. Constrains of existing CLV models for modelling the sustainability of KRIM

Traditionally, CLV model is mostly developed based on financial, accounting or non-spatial based instruments. In the firm-based CLV model, CLV is developed based on accounting or financial based measurement with highly consideration on items such as costs, expenses, investment, rate, and any kind of tangible values that was cited in major works of [40], [41], and [42]. In contrast, in the perspective of customer-based CLV model, CLV is more on customer-related behavior purchasing activity, such

as recency, frequency, and monetary instruments, as described as RFM model by [41]. Similarly, both of perspectives are modelled either based on mathematical or statistical modelling with finale aim to estimate the profitability customers to the business. However, all of CLV models are not applicable to visualize the CLV results in term of location, as customer located in the marketplace. Although, there are new CLV models continuously introduced and applied in the industry, as well as ICT-based model and, or even data mining or neural networks based model, similarly, those models have no capability to visualize the CLV of KRIM as different location of KRIM has different environment. In fact, most of traditional CLV models are not able to model the non-financial factor surrounding the marketplace of KRIM where it can affect the sustainability of KRIM in current and future performance.

The traditional CLV model as well as financial/account types models, CRM/marketing types models, operation/decision science types models and ICT/Computer science based models consistently apply financial or accounting related instruments. For example, Customer Segment Knowledge Model by [39] has utilized financial based instruments, but does not support any analysis related to spatial location of customer. In fact, non-financial instrument such as location factor can affect the profitability of business as mentioned in some work of [40], [41], and [42], This is also supported by [43] as they noted that predicting the CLV of a customer requires several related factors to spatial location. The predicted problem is transformed to a problem of creating a mapping function having all related features as its variables. Thus, according to these scholars new technique must be introduced for modelling the CLV of KRIM by integrating the non-financial variables into it.

B. Kedai Rakyat 1Malaysia (KRIM) and CLV Issues

In Malaysia, Kedai Rakyat 1Malaysia (KRIM) is the top issues of Malaysian society that has greater contribution to the whole lifetime value of 'the Rakyat'. KRIM is a shop operating on a mini market format, which provides various basic necessities at low prices. The existence of 'Kedai Rakyat 1 Malaysia' will also act as the medium for the Government to control prices and lessens the monopolization of products which has long been dominated by the multinational manufacturers. However, KRIM will face a lot of challenge especially huge competition with other business that also offers low prices scheme. [43] noted

competitive advantage is a significant and has long-term benefits that retailers enjoy over its competition. Competitive advantages will lead the companies to bring themselves into the right way forward and requires retailer to scan and follow the current change of external and internal environment of business, in order to generate new knowledge to them. Similarly, [33] raised-up that competition is thorny issue where lack of differentiation among competitors and this is actually a dangerous situation for retailers. By taking these premises in a context of this study, the KR1M faces huge competition where it will involve large number of customers, competitors, products and a lot more, as explained by [38] and [43] of these, [44], cited as customer is the key factor that can influence the key performance indicator of the profitable business, includes non-profit business like KR1M.

Malaysia is a multicultural society in which several ethnic groups like Malay, Chinese, Indian, Iban, Melanau, Kadazan, and many more live together. The existing multi ethnicity in Malaysia will create unique needs and demand of food and product purchase from the hypermarket. Every ethnic has their own demand on products. This is in a line of KR1M expansion on the whole state of Malaysia. Currently, the government had already opened 85 KR1M in the peninsula, namely 25 in 2011 and 60 more in 2012 at a cost of RM40 million. Locations for the 33 KR1M have been identified as reported in Bernama (Feb 07, 2013). The issue is how KR1M can predict the behaviour of the customers on purchasing activity without understanding their basic demographic background. Therefore, demographic and customers' behaviour should be include in predict the CLV of KR1M where these data will be useful to visualize the sustainability of KR1M.

III. RESEARCH METHODOLOGY

The method used in this study was exploration study by testing and evaluating the performance of the eight (8) GIS open sources such as Quantum GIS, PostGIS, GeoServer and MapServer, OpenLayers and Leaflet, GDAL/OGR, Pythonic Spatial Libraries, GeoNode and MapStore, and Cloud-Native GIS Tools. Testing and evaluation of the GIS open sources will be apply by explore, testing and evaluating the feature, capability and platform as offers by the GIS open sources. There are five (5) panel of expertise used in this evaluation process. Process of explore, testing and evaluating the GIS open sources will take about 48 hours for each of the software. There are two major aspects concern in the

exploration are aspects of suitability of GIS open source for mapping the CLV of KR1M and capability of GIS open source software for estimate the sustainability of KR1M. After that, the panel will report the finding, which mostly based on their experience about the software. In addition, ranking scale also used and marks by the expertise, as finale result of the exploration study.

Geographic Information Systems (GISs) have emerged as effective tools for the mapping of business. There are several types of GIS software on the market, but the most widely used are QGIS [41] and ArcGIS [43]. GISs are powerful tools for collecting, storing, retrieving, transforming, and visualizing spatial data. Their ability to analyze and visualize agricultural environments and workflows has proven to be beneficial for the agricultural sector [44]. GIS technology is becoming an essential tool for combining different sources of data, such as data acquired by drones, airborne sensors, and satellites [45].

There are many commercial GIS software available for GIS applications such as ESRI's ArcGIS, Geomedia, MapInfo Professional, Global Mapper, manifold GIS, Small World, Bentley Map, Map viewer etc. ArcGIS is well-established commercial software in GIS industry. In the field of GIS open source software experienced a boost over last few years. GRASS, gvSIG, Open JUMP GIS, Quantum GIS (QGIS), uDig GIS, SPRING are open source Desktop GIS software. Geo Majas, GeoServer, MapFish, MapServer, and Open Layers are some of the open source Software for web mapping [45]. In this study, the exploration of GIS open sources is limited to the eight (8) GIS open sources, as mentioned above.

IV. RESULT AND DISCUSSION

This study explores the open-source GIS based on criteria, tools and core functionalities, include desktop GIS, web GIS, spatial databases, geospatial libraries, and cloud-native tools. In addition, it highlights the latest features, use cases, and integration strengths of these platforms, reflecting the practically used for mapping the spatial and non-spatial aspects of the KR1M.

A. Quantum GIS (QGIS)

Quantum GIS (QGIS) is most popular, leading GIS open sources and user friendly open source software for old and new users. It is licensed under GNU

public License and also called as the flagship of Desktop GIS. Anybody can download it and use freely as it works on multi-platform of windows, Linux and Mac platforms. A new mobile version is also developed for Android. There are plenty of supports, documents and tutorials available in QGIS for users. It can accept all types of data/information in different format and projections. It can perform different types of spatial analysis such as Terrain analysis, Transport Analysis, Hydrological Analysis, Network analysis, Spatial analysis, etc [41].

QGIS continues to be the most widely adopted open-source desktop GIS and its 2025 version (i.e QGIS 3.34 and beyond) has evolved into a comprehensive spatial analysis platform supporting both raster and vector based operations, with advanced symbology, and advanced real-time sensor integration. Some of key features of QGIS are includes

- Native support for data visualization (temporal and 3D data visualization).
- Tight integration with PostgreSQL/PostGIS, GeoServer, and OGC services.
- Enhanced support for machine learning plugins (e.g., Scikit-learn, TensorFlow).
- QField mobile app for field data collection and offline workflows.

B. PostGIS

Basically, PostGIS is a spatial database extension for the PostgreSQL DBMS and identified as Spatial Engine for PostgreSQL. PostGIS provides new types to PostgreSQL geometry, geography, raster, and topogeometry and SQL/MM OGC SFSQL compliant functions for doing GIS work such as cadastral management, back-end for Web mapping services. Its mean data visualization is available for mapping the spatial objects and possible for integrates spatial with non-spatial data in one platform.

The core features of PostGIS are geometric processing, geographic processing, raster processing and analysis in the database, 3D surface and volume support, topogeometry functions and topologies, geocoding and address standardization and also tools for loading data. The functionality of core features of PostGIS has extends PostgreSQL into a powerful spatial database engine. It remains the backbone for enterprise-scale spatial data infrastructure, supporting millions of transactions per day with geometry and geography types that

make PostGIS is suitable for managing the huge number of business networking spatially.

Key features of PostGIS are includes

- Better indexing for complex geometries using GIST and BRIN hybrids.
- Support for 3D spatial relationships and voxel data types.
- Integration with cloud-native architectures via Kubernetes and containerization.
- Built-in functions for trajectory analysis, topology validation, and spatial clustering.

The PostGIS implementation is based on light-weight geometries and indexes optimized to reduce disk and memory footprint. Using light-weight geometries helps servers increase the amount of data migrated up from physical disk storage into RAM, improving query performance substantially.

C. GeoServer and MapServer

GeoServer and MapServer are leading open-source tools for serving geospatial data through standard web services (WMS, WFS, WCS) and its OGC-Compliant Web Services. They provide essential backend services for modern web maps and APIs. GeoServer and MapServer are both popular open-source web GIS software used for publishing maps over the internet, but they have some key differences. They both support various OGC (Open Geospatial Consortium) standards like WMS, WFS, and WCS, allowing them to be used in a variety of web mapping applications.

GeoServer, written in Java, excels in its user-friendly web-based administration interface and support for transactional WFS (Web Feature Service), allowing for editing of feature services. Data is published via standards based interfaces, such as WMS, WFS, WCS, WPS, Tile Caching and more. GeoServer provided with with a browser-based management interface and connects to multiple data sources at the back end.

Meanwhile, MapServer, written in C, is known for its speed, particularly in WMS (Web Map Service) and its configuration and scripting capabilities. MapServer is widely known as one of the fastest mapping engines in the world. It is supported by a diverse group of organizations that fund enhancements and maintenance, and is administered within OSGeo by the MapServer Project Steering Committee. MapServer is driven by a very vibrant and helpful Open Source community.

Key features of GeoServer are includes

- Support for vector tiles (MVT), COG (Cloud-Optimized GeoTIFF).

- Integrated styling via SLD and CSS.
- WebSocket-based real-time layer updates.
- Docker and Helm chart availability for cloud deployments.
- Performance improvements for high-demand tile rendering.
- Native support for OGC API - Features and Tiles (the RESTful successor to WFS/WMS).

GeoServer strengths are includes

- User-friendly web interface: Easier to configure and manage through a web-based interface.
- WFS-T support: Supports transactional WFS, enabling editing of spatial data on the client-side.
- Java-based: Offers flexibility and platform independence due to being Java-based.
- Cascading WMS: Can proxy remote WMS services, allowing for integration and manipulation of external map data.

MapServer has strengths on some aspects of

- Speed and efficiency: Built in C, it leverages optimized libraries for spatial data handling and is known for its performance, especially with WMS;
- Lightweight: Generally considered a lightweight solution;
- Configurable and scriptable: Highly configurable and can be controlled through various scripting languages;
- Mature project: Has been under development for a long time, with a large and active community.

D. OpenLayers and Leaflet

Basically, OpenLayers and Leaflet are both popular JavaScript libraries for creating interactive web maps. OpenLayers and Leaflet are both prominent open-source JavaScript libraries for creating interactive web maps, each offering advanced capabilities tailored to different needs. It is Web Mapping Libraries. Leaflet is known for its simplicity and ease of use, making it suitable for smaller, less complex projects. OpenLayers, on the other hand, offers more advanced geospatial functionality and is better equipped to handle larger datasets and complex projections, making it a good choice for more demanding applications.

The functionality between them for advanced use cases often depends on some aspects:

- Complexity of geospatial data and projections: OpenLayers is preferred for highly complex data and custom projection requirements.

- Need for fine-grained control and customization: OpenLayers offers more control at a lower level.
- Reliance on pre-built solutions and ease of integration: Leaflet's plugin ecosystem can accelerate development for many advanced features.
- Performance requirements for large datasets: Both handle large datasets, but OpenLayers' rendering techniques are often more suited for extremely complex or high-resolution data

For client-side web mapping, OpenLayers and Leaflet continue to dominate. These JavaScript libraries help developers build highly interactive spatial applications without proprietary SDKs.

Some key features of OpenLayers of latest version 2025 are includes

- 3D globe visualization using Cesium integration.
- Native support for GeoPackage and vector tiles.
- Real-time layer updates from MQTT and WebSocket feeds.
- In addition, Leaflet's strengths are covers lightweight performance ideal for mobile and embedded devices; Integration with D3.js and Chart.js for spatial-analytical overlays; and community plugins for routing, clustering, and geo referencing.

Leaflet has advantages on some aspects of

- Simplicity and ease of use: Leaflet is known for its intuitive API and straightforward implementation, making it easy to get started with web mapping.
- Lightweight: It has a small footprint and loads quickly, making it suitable for mobile-friendly applications.
- Extensive plugin ecosystem: Leaflet offers a wide range of plugins for added functionality.

OpenLayers has advantages on some aspects of

- Advanced geospatial functionality: OpenLayers provides a rich set of tools for handling projections, coordinate transformations, and working with various data formats.
- Support for large datasets: It's designed to handle large and complex geospatial datasets efficiently.
- Highly customizable: OpenLayers offers extensive customization options for

advanced GIS features and map interaction.

E. GDAL/OGR (The Universal Translator)

The Geospatial Data Abstraction Library or GDAL, is a widely used open-source software library for reading and writing raster and vector geospatial data formats. It is released under an MIT-style free software license by the Open Source Geospatial Foundation (OSGeo). GDAL/OGR also often referred to as "The Universal Translator," which is a powerful open-source library and set of command-line tools for reading and writing geospatial data in various raster and vector formats. Functionally, GDAL/OGR acts as a bridge between different data formats, enabling users to convert, process, and manipulate geospatial information.

GDAL remains a cornerstone for raster and vector data conversion. In current market of 2025, it supports over 250 formats and is optimized for high-performance ETL (Extract, Transform, Load) operations in large spatial datasets. Common features of GDAL/OGR are includes:

- Native support for AWS S3 and Azure Blob Storage.
- Enhanced streaming for massive remote sensing datasets (Sentinel, Landsat).
- Integration with Python, C++, and Rust for faster geoprocessing pipelines.

In detail, some key aspects of GDAL include:

- **Data Translation and Processing:** GDAL serves as a translator library, providing a unified abstract data model for both raster and vector geospatial data across numerous supported formats. This allows applications to interact with diverse data sources consistently.
- **Command-Line Utilities:** In addition to its library functions, GDAL includes a suite of powerful command-line utilities for common geospatial tasks like data format conversion, re-projecting, mosaicking, and general data manipulation.
- **Broad Adoption:** GDAL is the most widely used geospatial data access library and forms the primary data access engine for many popular Geographic Information Systems (GIS) applications and software packages, including QGIS, GRASS GIS, MapServer, and more.
- **OGR Simple Features Library:** A component of GDAL is the OGR Simple Features Library, which specifically handles vector geographic data, enabling

the reading and writing of various standard vector formats.

- **Multi-platform and Multi-language Support:** GDAL is cross-platform, available on Linux/Unix, macOS, and Windows, and its core C++ library can be accessed through bindings in various programming languages, including Python, Java, and C#.

In addition, some functionality of GDAL are shows in Table 1.0.

Table 1: Functionality of GDAL

Data Abstraction	GDAL/OGR provides a consistent, abstract data model (for both raster and vector data), allowing applications to work with different formats (through a unified interface).
Format Support	It supports a vast number of formats (raster and vector), with it a versatile tool for handling diverse geospatial data.
Command-line Utilities	GDAL/OGR includes a suite of command-line utilities for tasks like data conversion, re-projection, and other geoprocessing operations.
Library for Developers	GDAL/OGR is also available as a C/C++ library, with bindings for various programming languages, that enabling developers to integrate its functionality into applications.
Open Source and Free	GDAL/OGR is released under a permissive open-source license, making it freely available for use and modification.
Widely Used	It's a foundational library in the geospatial industry, underpinning many popular GIS software packages and workflows.
Vector and Raster Support	GDAL handles both raster data (images, grids) and vector data (points, lines, polygons).
Spatial ETL	GDAL/OGR is commonly used for creating spatial ETL (Extract, Transform, Load) pipelines, allowing users to automate data processing workflows.

F. PyProj, Fiona, and Shapely (Pythonic Spatial Libraries)

Basically, python offers a rich ecosystem of libraries for working with spatial data, ranging from fundamental data handling to advanced analysis and

visualization. There are 3 major category are includes (a) Core Spatial Data Libraries; (b) Spatial Analysis and Visualization Libraries; and (c) Specialized Libraries, where each category as specific functions and works.

PyProj, Fiona, and Shapely are fundamental Python libraries within the geospatial ecosystem, often used in conjunction with other libraries like GeoPandas for comprehensive spatial data analysis. These Python libraries form the core of most geospatial data science workflows: In details,

- **PyProj:** This library provides a Python interface to the PROJ library, which is a powerful C++ library for cartographic projections and coordinate transformations. PyProj enables users to convert coordinates between different geographic reference systems (e.g., WGS84, UTM), perform geodetic calculations, and handle various aspects of spatial referencing. PyProj is used for handles projections and coordinate transformations (based on PROJ)
- **Fiona:** Fiona is enables reading/writing vector formats using GDAL. Fiona is designed for reading and writing vector geospatial data formats, Fiona acts as a Pythonic wrapper around the OGR Simple Features Library (part of GDAL). It simplifies the process of interacting with various file types like Shapefiles, GeoJSON, and KML, allowing users to easily load and save geospatial data in a familiar Python I/O style.
- **Shapely:** This library focuses on the manipulation and analysis of geometric objects in a 2D plane. Built upon the GEOS (Geometry Engine - Open Source) library, Shapely provides a rich set of functionalities for creating, transforming, and analyzing geometric shapes such as points, lines, and polygons. It allows for operations like buffering, intersections, unions, and calculating areas or lengths, all based on the principles of Simple Features Access. Shapely is provides geometric operations (e.g., intersection, buffer, union)

Some key features of Pythonic Spatial Libraries are includes

- Improved performance using Python 3.12 and multi-threading.
- Integration with Pandas and GeoPandas for spatial dataframes.
- Widely used in geospatial AI/ML model pipelines.

- Data cleansing and preprocessing for urban mobility datasets.
- Creating custom spatial analytics scripts in Jupyter notebooks.
- Automating map production workflows.

In essence, these libraries form a core toolkit for Python-based geospatial workflows: Fiona handles data input/output, Shapely provides the geometric processing capabilities, and PyProj manages coordinate system transformations.

G. GeoNode and MapStore(GeoCMS and GeoPortal Platforms)

Basically, for organizations needing collaborative geospatial content management and publishing, platforms like GeoNode and MapStore offer end-to-end web GIS solutions is the most suitable. Specifically, **GeoNode is a geospatial content management system**, a platform for the management and publication of geospatial data. It brings together mature and stable open-source software projects under a consistent and easy-to-use interface allowing non-specialized users to share data and create interactive maps. Data management tools built into GeoNode allow for integrated creation of data, metadata, and map visualizations. Each dataset in the system can be shared publicly or restricted to allow access to only specific users. Social features like user profiles and commenting and rating systems allow for the development of communities around each platform to facilitate the use, management, and quality control of the data the GeoNode instance contains.

Some key features of GeoNode are includes:

- Drag-and-drop web map creation.
- Role-based access control for layers and users.
- OGC-compliant service publishing with analytics dashboards.
- In addition, mapStore advantages are includes reactJS-based modular interface; thematic layer styling and spatial querying out of the box, and Integration with CKAN for open data portals.

There are 3 major core features of GeoNode:

- **Special data recovery:** includes powerful spatial search engine, federated OGC services and metadata catalogue.
- **Import and Manage:** Publish raster, vector, and tabular data; manage metadata and

associated documents; securely or publicly share data and versioned geospatial data editor.

- **Interactive Mapping:** GeoExplorer GIS client, graphical style editor, create multi-layer interactive maps, and share and embed maps in web pages.

MapStore is highly modular Open Source WebGIS framework developed by GeoSolutions to create, manage and securely share maps and mashups. This simple and intuitive framework is able to mix map contents provided by Google Maps, OpenStreetMap, other servers compliant to OGC standards (such as WFS, CSW, WMC, WMS, WMTS and TMS). In fact, MapStore is used to find, view and query published geospatial data and to integrate multiple remote sources into a single map; the result is an high quality and user friendly framework that allows different kind of use cases by harmonizing remote data with smart and advanced functionalities (like chart widgets, dashboards, timelines and others). MapStore resources are related to Maps, Dashboards and Stories; and its possible to create innovative and fascinating Application Context where users can save, manage and share its own resources by also managing access permissions to other groups of users.

As a standard geoportal product, it is a web-based product that allows providing a powerful and interactive geospatial WebGIS, it provides a direct and real-time access to geospatial data warehouses and it supports the most common standards formats available for geospatial data. In addition, MapStore also provides advanced spatial analysis capabilities that can be used to build WebGIS solutions through a powerful, dynamic and open geospatial application. Since MapStore is also a framework, you can use it to build your own WebGIS applications by using its plugins and modules.

H. Cloud-Native GIS Tools

Cloud-native GIS tools are Geographic Information System applications and services specifically designed to operate within a cloud computing environment. They leverage the scalability, flexibility, and accessibility of cloud infrastructure for spatial data storage, analysis, and visualization, offering advantages over traditional, server-based GIS.

Some key features of Cloud-Native GIS Tools are includes:

- **TerriaJS:** For building spatial data catalogs and 3D globe apps.
- **STAC (SpatioTemporal Asset Catalog):** A modern standard for organizing EO datasets, widely used in agriculture and disaster response.
- **Rasdaman:** Array database for large-scale time-series and climate data analytics.
- **Actinia:** REST API for scalable geoprocessing based on GRASS GIS.
- These tools support containerized, serverless, and scalable deployments, enabling organizations to manage petabytes of spatial data efficiently.

Some key characteristics of Cloud-Native GIS are includes

- **Cloud-Based Architecture:** Instead of relying on local servers, these tools utilize cloud resources like virtual machines, storage, and databases offered by providers such as AWS, Azure, or Google Cloud.
- **Scalability and Elasticity:** Cloud-native GIS can easily scale resources up or down based on demand, handling large datasets and processing needs efficiently.
- **Microservices Architecture:** Cloud-native GIS often employs microservices, breaking down functionality into smaller, independent services that can be deployed and scaled individually.
- **Data Accessibility and Collaboration:** Cloud-native GIS makes it easier to share and collaborate on spatial data and analysis through web-based interfaces and APIs.
- **Automation and Serverless Workflows:** They can automate tasks and leverage serverless functions to process geospatial data without direct management of compute resources.
- **Support for Cloud-Native Formats:** Cloud-native GIS tools increasingly support formats like GeoParquet and Cloud-Optimized GeoTIFF (COG) for efficient storage and access to spatial data.

Based on review as above, Cloud-Native GIS is the most preferred choice for mapping the customer lifetime value of KR1M based on advantages as:

- **Reduced infrastructure costs:** Pay-as-you-go pricing models for cloud resources can significantly lower infrastructure costs compared to maintaining on-premise servers.

- Improved scalability and performance: Cloud resources can be easily scaled to handle large datasets and complex analysis tasks.
- Enhanced collaboration and data sharing: Cloud-based platforms enable teams to collaborate in real-time on spatial data and projects.
- Faster development and deployment: Cloud-native tools often offer APIs and pre-built components that can accelerate the development and deployment of GIS applications.
- Access to advanced technologies: Cloud providers offer access to cutting-edge technologies like AI and machine learning for geospatial analysis.

For mapping the location of KR1M, location of customer and the spatial value of KR1M, Cloud-Native GIS Tools are available and possible to used are includes

- ArcGIS Online: A cloud-based platform from Esri that provides a wide range of GIS capabilities for professionals.
- Felt: A cloud-native, collaborative mapping platform built on PostGIS and PostgreSQL.
- Google Earth Engine: A platform for planetary-scale geospatial analysis with a vast catalog of satellite imagery and geospatial datasets.
- CARTO: A cloud-native platform focused on location intelligence and spatial analysis.
- SuperMap GIS: A cloud GIS server based on a high-performance cross-platform GIS kernel, supporting massive vector/raster data publishing and microservice integration.
- Atlas: A browser-based GIS platform focused on simplicity and collaboration.
- QGIS: While traditionally a desktop application, QGIS is increasingly being used in cloud environments and has a cloud-native plugin system.
- Google Cloud Platform (GCP) and BigQuery: GCP offers various services for geospatial analysis, including BigQuery for handling large datasets.
- Spatial AI: Tools like Flai leverage AI and cloud computing for automated point cloud classification and other advanced analysis tasks.

The advantages of Cloud-Native GIS for mapping the CLV of KR1M are possible in aspects of

- Scalability: Cloud-native GIS can easily scale resources up or down based on

demand, handling large datasets and complex analyses efficiently.

- Accessibility: Geospatial data and applications are accessible from anywhere with an internet connection, facilitating collaboration and remote work.
- Flexibility: Cloud-native GIS platforms offer a wide range of tools and services that can be customized and adapted to specific project needs.
- Integration: Cloud-native GIS seamlessly integrates with other cloud services and data sources, streamlining workflows and enhancing data analysis.

Table 2.0 shows the overall result of the study. On the side of suitability of the GIS open sources for mapping the CLV, most of panels agreed that all software suitable for mapping purposes, with 5 over 5 (5/5) expertises agreed on Quantum GIS; 3/5 (Post GIS); 3/5 (GeoServer and MapServer); 4/5 (OpenLayers and Leaflet); 3/5 (GDAL/OGR); 3/5 (Pythonic Spatial Libraries); 4/5 (GeoNode and MapStore) and 5/5 (Cloud-Native GIS Tools).

Table 2.0: Overall results of the Study.

GIS Software	Suitability for mapping CLV	Capability for estimate the sustainability
Quantum GIS	5/5	4/5
PostGIS	3/5	3/5
GeoServer and MapServer	3/5	3/5
OpenLayers and Leaflet	4/5	3/5
GDAL/OGR	3/5	3/5
Pythonic Spatial Libraries	3/5	3/5
GeoNode and MapStore	4/5	4/5
Cloud-Native GIS Tools	5/5	5/5

On the side of capability for estimate the sustainability of KR1M, most of panels agreed that all software suitable for mapping purposes, with 4 over 5 (5/5) expertises agreed on Quantum GIS; 3/5 (Post GIS); 3/5 (GeoServer and MapServer); 3/5 (OpenLayers and Leaflet); 3/5 (GDAL/OGR); 3/5 (Pythonic Spatial Libraries); 4/5 (GeoNode and MapStore) and 5/5 (Cloud-Native GIS Tools).

In term of ranking scale, Table 3.0 shows the result and revealed that Cloud-Native GIS Tools is the most preferred choices for mapping the CLV

and estimate the sustainability of KR1M. The Cloud-Native GIS Tools ranks as number 1 from all panel (expertise) in the study.

Table 3.0: Overall raking score bt the expertise.

GIS Software	Pane 1 1	Pane 1 2	Pane 1 3	Pane 1 4	Pane 1 5
Quantum GIS	2	2	3	2	2
PostGIS	5	6	6	8	5
GeoServer and MapServer	6	5	5	6	6
OpenLayers and Leaflet	4	4	4	5	4
GDAL/OG R	7	8	7	4	7
Pythonic Spatial Libraries	8	7	8	7	8
GeoNode and MapStore	3	3	2	3	3
Cloud-Native GIS Tools	1	1	1	1	1

V. CONCLUSION

Overall, open-source GIS tools offer the flexibility, scalability, and innovation edge required for modern geospatial applications. They are not only for mapping purposes, but covers foundational to big application such as smart cities, digital twins, autonomous systems, and environmental sustainability projects. In another aspect, as industries increasingly rely on geospatial intelligence for decision-making, the open-source ecosystem offers a viable, future-proof pathway. The shift from tool usage to stack orchestration, where tools like QGIS, PostGIS, GeoServer, and OpenLayers work seamlessly together, defines the new era of interoperable and composable geospatial solutions.

In conclusion, Cloud-native GIS refers to Geographic Information Systems designed and built to leverage the scalability, flexibility, and accessibility of cloud computing environments. It moves away from traditional on-premise GIS infrastructure by utilizing cloud services, microservices, containers, and serverless computing. This approach allows for efficient storage, analysis, and visualization of spatial data, facilitating collaboration and real-time data processing. Utilizing these platform will make the mapping process of CLV are become more advanced and sophisticated, according to the latest trend of GIS world.

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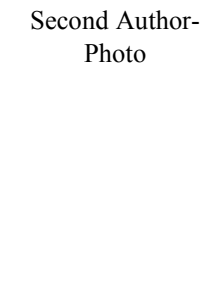
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Sistem Pengurusan Inventori Berasaskan Analisis ABC, Suatu Kajian Kes di PChem Supply & Services Sdn. Bhd.

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Abstrak

Sistem pengurusan inventori berasaskan Analisis ABC adalah pendekatan pengurusan inventori yang menyediakan penyelesaian kepada susunatur yang lebih sistematik dan efektif serta membantu capaian yang lebih mudah kepada inventori dengan mengklasifikasikan item inventori kepada 3 kelas utama iaitu Kelas A, Kelas B dan Kelas C berdasarkan peratus kekerapan penggunaannya. Kajian kes berbentuk kualitatif melalui pemerhatian langsung terhadap sistem pengurusan inventori berkomputer dan susunatur inventori fizikal di Unit Stor dan Logistik, temubual berstruktur terhadap responden daripada kalangan pengurus dan kakitangan dan semakan dokumen yang berkaitan mendapati terdapat permasalahan dan isu dari segi ketepatan dan capaian inventori dalam pengurusan inventori di Syarikat PChem Supply & Services Sdn Bhd. yang boleh ditambahbaik dengan mempraktikkan pengurusan inventori berasaskan Analisis ABC. Oleh itu, cadangan penambahbaikan terhadap pengurusan inventori telah diberikan dan dilaksanakan kepada sistem pengurusan inventori berkomputer dan sistem pengurusan inventori fizikal syarikat. Hasilnya, objektif kajian kes ini telah tercapai dengan pengurusan inventori yang lebih sistematik, efektif dan capaian inventori yang lebih mudah.

Kata kunci: Kajian Kes; Sistem Pengurusan Inventori; Analisis ABC

I. PENGENALAN

Sistem pengurusan inventori merupakan aspek pengurusan yang sangat penting dalam sesebuah organisasi, khususnya bagi syarikat yang jumlah pusinganti inventornya adalah tinggi seperti di Syarikat PChem Supply & Services Sdn Bhd. Syarikat ini merupakan syarikat pembekal bahan kimia dan peralatan keselamatan yang utama di Pantai Timur, Malaysia. Oleh itu, sistem pengurusan inventori yang cekap adalah penting bagi mengelakkan daripada pembaziran, stok tamat tempoh, risiko keselamatan dan susunatur yang tidak sistematik [1][2][3].

Kajian kes berbentuk kualitatif menggunakan instrumen temubual berstruktur, pemerhatian dan semakan dokumen terhadap sistem pengurusan inventori fizikal dan berkomputer di Syarikat PChem Supply & Services Sdn Bhd untuk mengumpul data dan menjalankan analisis kajian kes [4] telah digunakan. Pengkaji mengambil peluang untuk bersama-sama pihak pengurusan

syarikat untuk melaksanakan cadangan dan penambahbaikan daripada hasil penemuan kajian kes ini. Kemudiannya melaporkan cadangan dan penambahbaikan sebagai bukti hasil kajian kes ini.

Syarikat menggunakan dua lot utama bangunannya sebagai stor untuk penyimpanan inventori yang dibeli dan dijual. Sistem pengurusan inventori di syarikat dilaksanakan secara fizikal dan berkomputer oleh pegawai-pegawai yang bertanggungjawab Pengurus Besar (R1), Pengurus Kawalan Kualiti (R2), Pengurus Perakaunan (R3), Pegawai Pembelian dan Jualan (R4) serta dua (2) Pegawai Stor dan Logistik yang merupakan kakitangan stor dan logistik (R5) dan kakitangan penghantaran (R6).

Sistem pengurusan inventori yang sistematik dan berkesan pastinya dapat membantu syarikat mengenalpasti kedudukan dan ketersediaan inventori dengan tepat [1] apabila Pesanan Belian (PO) diterima. Namun, sistem pengurusan inventori sedia ada tidak dapat menyediakan notifikasi awal

terhadap kedudukan dan ketersediaan inventori (R1). Ini menyebabkan, sekiranya, inventori tidak mencukupi atau tersedia untuk sesuatu PO, pelanggan terpaksa menunggu pesanan baharu dibuat oleh Syarikat melalui pembekalnya untuk memenuhi PO tersebut (R4).

Hasil daripada temubual berstruktur terhadap R1, R3 dan R4 mendapati terdapat keluhan dan aduan terhadap sistem pengurusan inventori syarikat apabila berlaku kesukaran dan masalah dalam mengenalpasti ketepatan dan kedudukan inventori melalui *UBS Inventory & Billing System* berbanding ketepatan dan kedudukan inventori di Stor dan Logistik fizikal yang dianggap sebagai isu kecil tetapi ia memberikan kesan yang besar kepada reputasi syarikat terhadap pelanggan-pelanggannya. Oleh itu, pengurusan inventori yang tinggi kebergantungan kepada sistem berkomputer perlu dikaji dan dikenalpasti penambahbaikannya.

Oleh itu, objektif kajian ini adalah:

1. Menenalpasti sistem pengurusan inventori yang digunakan oleh syarikat.
2. Menenalpasti ciri-ciri sistem pengurusan inventori sebagai sistem kawalan inventori.
3. Mencadangkan langkah-langkah penambahbaikan ke arah pengurusan inventori yang sistematik dan cekap.

II. KAJIAN LITERATUR

Inventori merupakan komponen utama dalam pengkelasan aset sesebuah perniagaan dan memainkan peranan utama dalam memenuhi permintaan pelanggan. Oleh itu pelaburan yang signifikan diperuntukkan oleh syarikat untuk mengurus inventori secara berkesan [2]. Pengurusan inventori yang cekap dan berkesan akan membantu mengurangkan pembaziran bahan mentah, penjimatan kos penyimpanan dan boleh meningkatkan keyakinan pelanggan [5].

Pengurusan inventori didefinisikan sebagai kaedah susunatur, penyimpanan dan penggantian senarai inventori yang berada di stor [6]. Ia merujuk kepada penggunaan sistem pengurusan inventori secara fizikal untuk mengawal kemasukan, penyimpanan dan pengeluaran barang dari stor atau gudang secara sistematik. Ia bertujuan untuk memastikan stok mencukupi tanpa berlebihan, serta mengelakkan pembaziran dan kerugian kos penyimpanan [5].

Perkembangan teknologi digital khususnya penggunaan sistem perakaunan berkomputer seperti *UBS Inventory and Billing System* telah membantu syarikat mengurus inventori dengan lebih berkesan dan cekap. Modul yang tersedia membantu syarikat sebagai alat kawalan inventori. Khususnya dengan

melaksanakan pengurusan inventori menggunakan kaedah pergerakan inventori (*FIFO, LIFO atau AVERAGE*), pengurusan kedudukan inventori semasa (*balance b/d, minimum level, maximum level and reorder level*) dan lain-lain yang boleh ditetapkan/dipilih. Namun ia tidak mengubah peranan pengurusan inventori secara fizikal terhadap pergerakan inventori, penyimpanan dan pemprosesan transaksi perniagaan [7] kerana pengurusan inventori secara fizikal adalah menyokong kepada sistem pengurusan inventori secara berkomputer.

Pendekatan pengurusan inventori secara fizikal yang biasa diterapkan oleh syarikat-syarikat adalah pendekatan Analisis ABC [6]. Analisis ABC diterapkan dalam pengurusan inventori dengan mengasingkan inventori kepada tiga kategori utama berdasarkan jumlah kos penggunaannya [8], ia selari dengan pengkelasan dibuat berdasarkan jumlah nilai ringgit dan kekerapan penggunaannya [9]. Dengan ini pengurusan inventori menjadi lebih cekap dengan melakukan susunatur inventori berdasarkan keutamaan dan sumbangannya kepada perniagaan contohnya, A merujuk kepada inventori paling penting, B merujuk kepada inventori sederhana penting dan C merujuk kepada inventori yang kurang penting [8]. Pengurusan inventori menggunakan Analisis ABC terbukti membantu pihak pegawai stor menenalpasti kedudukan inventori di dalam stor dan memudahkan pengeluaran barangniaga apabila jualan dan lain-lain aktiviti kawalan inventori berlaku [9].

Dengan gabungan sistem pengurusan inventori berkomputer (*UBS Inventory and billing System*) dan pengurusan inventori secara fizikal seperti Analisis ABC dan FIFO dalam perniagaan khususnya, pegawai perakaunan dan pegawai stor dapat menenalpasti stok berlebihan atau kekurangan, stok tamat tempoh, rekod idak tepat, menjimatkan ruang dan kos penyimpanan serta sisa-sisa atau bahan buangan yang tidak dikendalikan dengan cekap.

III. METODOLOGI

Kajian kes ini adalah kajian berbentuk kualitatif. Di mana, sampel responden dipilih secara non-probabiliti menggunakan teknik *judgemental* yang terdiri daripada dua (2) responden yang merupakan pihak pengurusan dan tiga (4) responden di kalangan pekerja syarikat yang terlibat secara langsung dengan proses dan prosedur pengurusan inventori.

Kaedah ini adalah bersesuaian dan diharap dapat mencapai objektif kajian [4]. Pengumpulan data daripada responden dilakukan melalui pemerhatian, temu bual, dan analisis dokumen dalaman syarikat. Pendekatan ini membolehkan penyelidik memahami proses sebenar pengurusan inventori yang diamalkan oleh syarikat [4][10].

Kaedah pemerhatian yang digunakan melibatkan pemerhatian secara terus (*direct observation*) melalui penglibatan (*participant-observation*). Menggunakan kaedah ini memungkin interaksi sosial secara langsung pengkaji dan subjek kajian membolehkan pengkaji memahami dengan jelas isu-isu yang ingin dikaji [11]. Ini dapat dilakukan dengan berkesan kerana pengkaji menjalani Latihan Sangkut Industri selama 28 hari di syarikat yang dikaji.

Temubual menggunakan soalan berstruktur digunakan untuk mendapatkan maklumbalas daripada responden. Di mana satu set soalan berbentuk pertanyaan disediakan untuk memastikan responden menjawab sesi temubual secara terarah kepada persoalan kajian dan pengkaji juga tidak tertinggal persoalan-persoalan yang ingin dikaji [10].

Di samping itu, pengumpulan data menggunakan analisis dokumen dapat memberikan maklumat yang relevan dengan persoalan-persoalan yang ingin dikaji. Dokumen-dokumen yang dianalisis adalah dokumen asal yang tersedia dan tidak boleh ditipu [10][12]. Dokumen-dokumen yang dianalisis adalah termasuk *invoice*, *purchase order*, *sales order*, *quotation* dan lain-lain dalam bentuk fizikal dan melalui sistem perakaunan berkomputer (*UBS Inventory and Billing*).

Objektif akhir kajian kes ini adalah untuk mencadangkan suatu pendekatan praktikal kepada syarikat untuk penambahbaikan pengurusan inventori sediaada. Kajian kes ini mengenengahkan pendekatan Analisis ABC untuk susunatur inventori yang dicadangkan.

Manakala kaedah susunatur inventori menggunakan Analisis ABC adalah berdasarkan pengkelasan inventori kepada 3 kelas utama iaitu Kelas A, Kelas B dan Kelas C berdasarkan nilai ringgit (jualan) dan kekerapan penggunaan inventori [9][13][14][15].

IV. DAPATAN

Seramai enam (6) responden telah dipilih untuk sesi temubual berstruktur yang dilakukan. Responden terdiri daripada Pengurus Besar (R1), Pengurus Kawalan Kualiti (R2), Pengurus Perakaunan (R3), Pegawai Pembelian dan Jualan (R4) serta dua (2) Pegawai Stor dan Logistik yang merupakan kakitangan stor dan logistik (R5) dan kakitangan penghantaran (R6).

Hasil temubual berstruktur dan pemerhatian fizikal di lampirkan seperti Jadual 1 dan Jadual 2 dibawah:

Jadual 1: Temubual berstruktur

Item		R1	R2	R3	R4	R5	R6
1	Perekodan penerimaan stok	UBS	UBS	UBS	UBS	UBS	Tidak terlibat
2	Sistem pengurusan inventori	UBS, tiada notifikasi stok tidak mencukupi.	UBS	UBS	UBS, tiada notifikasi stok tidak mencukupi.	UBS	UBS
3	Ketepatan stok	Tidak tepat	Tidak tepat	Tidak tepat	Rujuk UBS	Tidak tepat	Tidak pasti
4	Stok tamat tempoh	Ada	Ada	Ada	Ada	Ada	Ada
5	Audit inventori berkala	Tahunan	Tahunan	Tahunan	Tahunan	-Tahunan -selepas urusaniaga	Tahunan

Jadual 2: Pemerhatian Fizikal

Item		Ulasan
1	Susunatur Stor	Teratur, tetapi terdapat stok yang berada pada label yang salah.
2	Lebel yang tekini dan tepat	Label khusus kepada stok tidak jelas. Contohnya pengeluaran, jenis, saiz dan nombor rak.
3	Pemantauan tarikh luput	Pemantauan tidak menyeluruh. Terdapat stok yang luput tarikh masih berada di rak-rak inventori.
4	Sistem inventori digital	Sistem inventori seperti QR code. Bar code dan POS Tidak digunakan
5	Sistem Pengurusan Inventori	UBS Accounting System merupakan pengkalan data utama transaksi perniagaan syarikat. Penetapan unit <i>minimum level</i> , <i>maximum level</i> dan <i>re-order level</i> tidak dipraktikkan.

Dapatan daripada temubual berstruktur (Jadual 1), pemerhatian (Jadual 2) di atas dan dokumen *inventory maintenance* mendapati sistem pengurusan inventori di Syarikat boleh dibahagikan kepada dua (2) jenis sistem pengurusan inventori iaitu:

A Pengurusan Inventori Fizikal

Sistem pengurusan inventori fizikal berlaku di Unit Stor dan Logistik di mana inventori yang diterima daripada pembekal akan didaftarkan setelah kuantiti dan kualiti yang diterima disahkan berdasarkan pesanan belian (PO). Pegawai stor (R5) akan mengemaskini rekod inventori dan disusun mengikut rak-rak yang disediakan berdasarkan jenama-jenama tertentu menggunakan kaedah *First in First Out (FIFO)*.

Manakala, pengeluaran inventori untuk jualan/penghantaran dilakukan oleh Pegawai Stor dan Logistik (R5) bersama pemandu (R6) dengan merujuk kepada dokumen *Delivery order (DO)* dan perlu disemak bersama dengan dokumen Sales Order (SO) yang disediakan oleh Unit Jualan (R4) untuk memastikan pengeluaran inventori dan kuantiti yang betul.

Pemeriksaan yang berterusan dan berkala sekurang-kurang setahun sekali dilakukan untuk memastikan inventori adalah tepat, tersedia dan pengasingan inventori perlu lupus dapat dikenalpasti pada masa yang tepat (R5). Tiada rekod fizikal seperti Kad Lejer Stor dipraktikkan.

B. Pengurusan Inventori Berkomputer.

Sistem pengurusan inventori berkomputer *UBS Inventory & Billing System* merupakan sistem pengkalan data utama pengurusan inventori di Syarikat dengan menyelaraskan inventori yang diterima (*Purchase Order*) dan dijual (*Sales Order*) dikemaskini oleh Pegawai Stor dan Logistik (R5) yang diselai oleh Pengurus Perakaunan (R3) menggunakan *UBS Inventory & Billing System*.

Pengurus Perakaunan bertanggungjawab untuk menetapkan kriteria maklumat-maklumat inventori yang akan direkodkan menggunakan *UBS Inventory & Billing system*. Manakala Pegawai Jualan (R4) pula akan merujuk baki terkini (*B/F*) inventori menggunakan *UBS Inventory & Billing System* semasa menerima dan mengesahkan ketersediaan stok di Unit Stor dan Logistiki sebelum pengeluaran Pesanan Jualan (SO).

Pesanan Jualan yang telah lengkap akan disertakan invois dan Pesanan Penghantaran (DO) untuk penghantaran pesanan pelanggan oleh Pegawai Stor dan Logistik (R5).

Daripada dapatan di atas, punca kepada isu-isu yang dibangkitkan oleh Pengurus Besar (R1), Pengurus Kawalan Kualiti (R2), Pegawai Belian dan Jualan (R4) dan Pegawai Stor dan Logistik (R5) dapat dikenalpasti dan memerlukan cadangan dan penambahbaikan yang sesuai iaitu:

- a) Kebergantungan syarikat kepada *UBS Inventory and billing System* adalah tinggi kerana rekod inventori tidak disimpan atau tidak boleh dirujuk di stor fizikal iaitu kad ledger stor. Ini menyebabkan pengiraan inventori secara fizikal tidak tepat berbanding maklumat daripada *UBS Inventory and billing System*.
- b) Pemeriksaan inventori secara berterusan khususnya setelah jualan berlaku tidak dipraktikkan secara konsistant menyebabkan susunan dan jumlah unit inventori di stor tidak tepat, tercicir dan inventori luput tarikh berlaku.
- c) Ketersediaan stok dan stok tidak mencukupi pesanan pelanggan (PO) hanya disedari apabila menerima pesanan pelanggan. Ia perlu dirujuk langsung kepada pihak pengurus Stok dan Logistik (R5).
- d) Stok tamat tempoh tidak diurus dengan sistematik, Ini menunjukkan kaedah FIFO tidak dipraktikkan dengan baik menyebabkan stok luput tarikh tidak disedari.
- e) Penggunaan *UBS Inventory and billing System* tidak dikemaskini dan tidak didaftarkan berdasarkan penempatan inventori di rak-rak yang disediakan.
- f) Modul *UBS Inventory and billing System* menyediakan menu kawalan pengurusan inventori yang lengkap seperti *minimum level, maximum level dan re-order level*. Namun, tidak dimanfaatkan untuk tujuan kawalan inventori menggunakan *UBS Inventory and billing System* oleh Pengurus Perakaunan Syarikat.

Perkara-perkara a hingga f yang dinyatakan di atas telah memberi kesan signifikan terhadap kedudukan dan susunatur inventori di Unit Stor dan Logistik yang sediaada.

V. PERBINCANGAN DAN KESIMPULAN

Bagi mencapai objektif-objektif kajian kes ini, syarikat perlu mengemaskini dan menambahbaik sistem pengurusan inventori sediaada samada *UBS Accounting System* atau Sistem Pengurusan Inventori fizikal di Unit Stor dan Logistik.

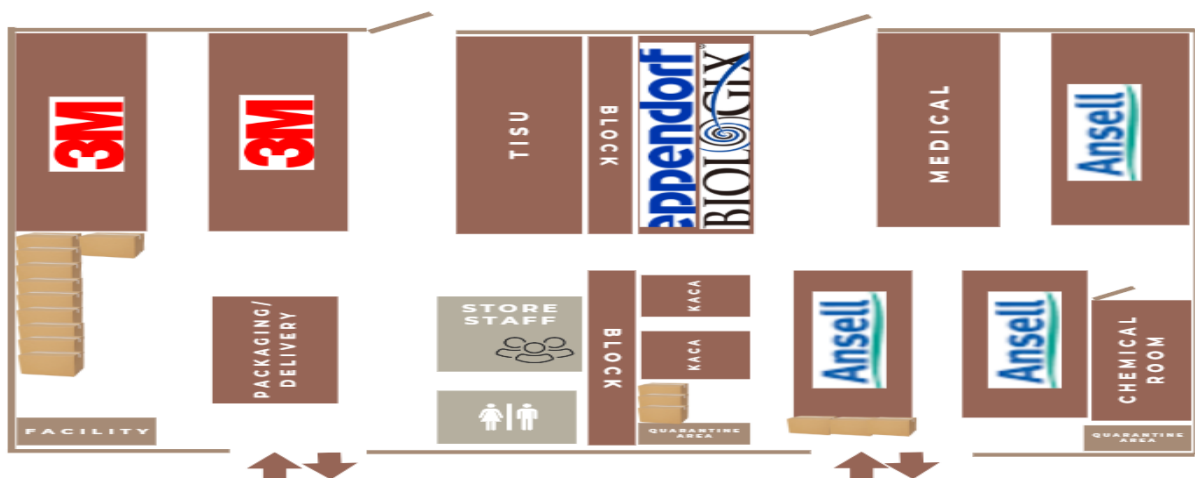
Bermula dengan penetapan kuantiti *minimum level*, *maximum level* dan *re-order level* menggunakan *UBS Inventory and Billing System* sebagai persediaan awal sekiranya kuantiti berada pada tahap-tahap tersebut maka tindakan awal dapat diambil [6].

Ia akan menjadi sistem kawalan inventori yang berkesan kepada syarikat walaupun ia tidak dapat menggantikan sistem kawalan pengurusan inventori secara fizikal [7].

Pengurusan inventori yang lengkap bagi sesebuah syarikat mestilah menyeluruh, bukan sahaja dari segi penggunaan teknologi terkini seperti penggunaan *UBS Inventory and Billing system* malah ia perlu diselaraskan dengan susunatur yang sistematik dan berkesan [5].

Rajah 1 dan Rajah 2 di bawah menunjukkan kedudukan dan susunatur inventori sediaada di syarikat yang tidak sistematik dan ditemui juga inventori luput tarikh serta kaedah FIFO tidak diberikan perhatian.

Rajah 1: Susunatur Inventori



Rajah 2: Susunatur Tidak Sistematik, Stok Luput Tarikh Ditemui dan FIFO



Oleh itu pendekatan susunatur inventori menggunakan Analisis ABC digunakan untuk merekabentuk dan menetapkan kedudukan susunatur yang sistematik dan berkesan [1][2][3][6].

Susunatur menggunakan pendekatan Analisis ABC [9] dan pengalaman R5 dalam mengurus inventori syarikat dilaksanakan berdasarkan ketetapan Jadual 3 berikut:

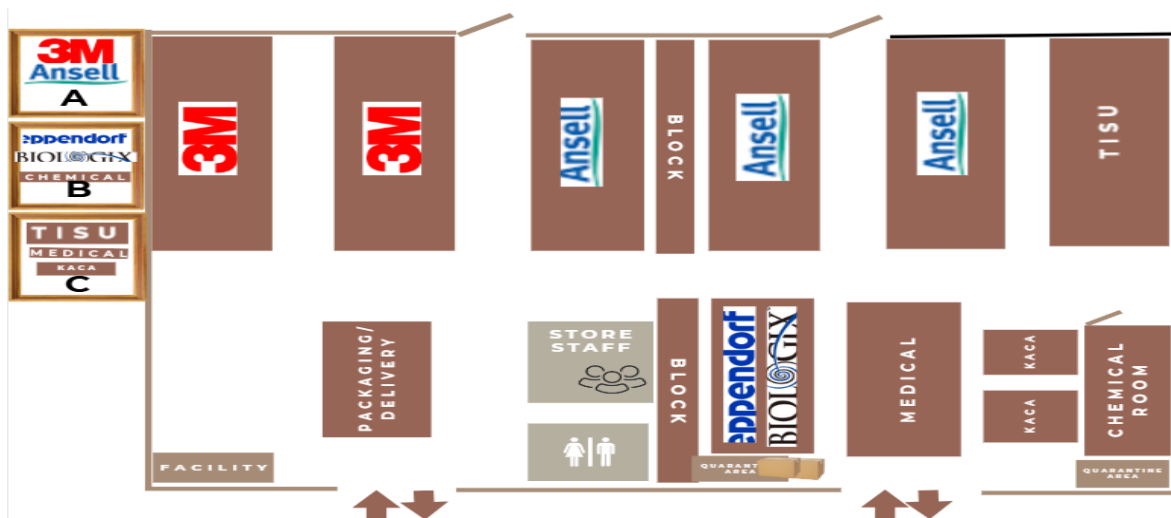
Jadual 3: Susunatur Inventori Analisis ABC

Nilai Sumbangan inventori	A (70%)	B (25%)	C (5%)
Pengkelasan Inventori	3M ANSELL	Eppendorf Biologic Cemical	Tisu Medical Kaca
Penjagaan inventori Kedudukan	Tinggi Depan	Sederhana Tengah	Rendah Belakang

Cadangan penyusunan semula inventori di Unit Stor dan Logistik adalah berdasarkan nilai inventroi yang memberikan sumbangan yang tinggi kepada syarikat dengan menilai kekerapan inventori dijual. Inventori ini perlu berada lebih dekat dengan pegawai Stor dan Logistik untuk memudahkan pengeluaran dan kemaskini inventori secara berterusan [9]. Penilaian

pertama adalah dengan sumbangan sebanyak 70%. Ia diikuti oleh inventori yang sederhana dan rendah sumbangannya iaitu 25% dan 5%. Rajah 3 dan 4 di bawah menggambarkan perubahan yang dilakukan terhadap susunatur yang baharu berdasarkan Analisis ABC yang lebih sistematik, teratur dan kemaskini kaedah FIFO.

Rajah 3: Susunatur Inventori Analisis ABC



Rajah 4: Susunatur Sistemati, Teratur dan Kemaskini Keadah FIFO



VI. KESIMPULAN

Objektif utama kajian kes ini adalah untuk mengenalpasti dan membantu syarikat menambahbaik sistem pengurusan inventori sediaada dengan mengemukakan cadangan sistem pengurusan inventori yang sistematik dan berkesan terhadap sistem pengurusan inventori berkomputer dan sistem pengurusan inventori fizikal di syarikat.

Penambahbaikan terhadap sistem pengurusan berkomputer melalui penetapan awal maklumat *shelf*, *expired date*, *minimum level*, *maximum level* dan *reorder level* pada menu UBS *Inventori & Billing System* diselaraskan dengan susunatur inventori berdasarkan Analisis ABC telah berjaya memberi penyelesaian terhadap pengurusan inventori sediaada. Khususnya apabila ketepatan unit inventori daripada system berkomputer (*Stock Card*) dapat disahkan dengan tepat pada unit inventori di Stor dan Logistic fizikal.

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ANALISIS FAKTOR KEGAGALAN PELAJAR MENAMATKAN PENGAJIAN PROGRAM SIJIL ASAS TAHFIZ DI PSAS MELALUI TEKNIK KUMPULAN NOMINAL

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Abstrak

Kajian ini dijalankan untuk meneliti faktor-faktor yang menyumbang kepada kegagalan pelajar menamatkan pengajian dalam Program Sijil Asas Tahfiz di Politeknik Sultan Azlan Shah (PSAS). Isu ini dianggap kritikal kerana kadar pengekalan pelajar yang rendah boleh menjejaskan keberkesanan program, kelestarian institusi, serta pencapaian objektif pendidikan nasional dalam melahirkan huffaz berkemahiran. Bagi mencapai tujuan ini, kajian menggunakan Teknik Kumpulan Nominal (NGT) dengan melibatkan lima orang pensyarah sebagai pakar dan 26 orang pelajar yang tidak menamatkan pengajian sebagai responden. Analisis mengenal pasti lima faktor utama yang menyumbang kepada kegagalan pelajar, iaitu faktor pembelajaran, sosial dan keluarga, psikologi, persekitaran serta kemudahan fizikal, dan aspek institusi serta reka bentuk kurikulum. Faktor pembelajaran didapati paling dominan, diikuti oleh faktor sosial dan keluarga, psikologi, persekitaran, dan kurikulum. Penemuan ini menegaskan keperluan strategi pengajaran yang lebih berkesan, bimbingan motivasi berterusan, sokongan sosial daripada keluarga dan komuniti, serta penambahbaikan dalam reka bentuk kurikulum dan persekitaran pembelajaran yang kondusif. Implikasi kajian ini menunjukkan bahawa usaha kolektif antara pensyarah, pentadbir, keluarga, dan institusi perlu diberi penekanan bagi mengurangkan kadar kegagalan serta meningkatkan kejayaan akademik dan spiritual pelajar. Secara keseluruhannya, dapatan ini berpotensi menjadi rujukan penting dalam perancangan intervensi strategik bagi memperkukuh kelestarian program Sijil Asas Tahfiz di Politeknik Sultan Azlan Shah.

Kata kunci: *kegagalan pelajar, Program Sijil Asas Tahfiz, Teknik Kumpulan Nominal (NGT), faktor pembelajaran, sokongan sosial*

I. PENDAHULUAN

Sistem pendidikan memainkan peranan penting dalam membangunkan modal insan yang berkualiti dan menyumbang kepada kemajuan sesebuah negara. Dalam konteks pendidikan Islam di Malaysia, program tahfiz dilihat sebagai satu pendekatan yang berkesan dalam melahirkan generasi pelajar yang bukan sahaja mahir dalam hafazan al-Quran, tetapi turut cemerlang dari aspek sahsiah, akhlak, dan pencapaian akademik [1].

Politeknik Sultan Azlan Shah atau dikenali sebagai (PSAS), yang terletak di Behrang, Perak, telah memperkenalkan Program Sijil Asas Tahfiz sebagai inisiatif pendidikan integrasi antara pengajian akademik dan hafazan al-Quran. Program ini

dijalankan secara kerjasama dengan Jabatan Kemajuan Islam Malaysia (JAKIM), dan bertujuan membentuk pelajar yang mampu menyeimbangkan kecemerlangan duniawi dan ukhrawi [2].

Namun begitu, program ini turut berdepan dengan cabaran, terutamanya dari sudut kadar pelajar yang gagal menamatkan pengajian. Fenomena ini menimbulkan kebimbangan terhadap keberkesanan program serta keperluan untuk mengenal pasti faktor yang menyumbang kepada kegagalan tersebut [2]. Kajian-kajian terdahulu menyatakan bahawa faktor kegagalan pelajar boleh datang daripada pelbagai dimensi, termasuk faktor dalaman seperti motivasi sendiri, disiplin, dan pengurusan masa [3], serta faktor luaran seperti sokongan keluarga,

kemudahan pembelajaran, dan kaedah pengajaran yang sesuai [3].

Sehubungan itu, kajian ini dijalankan untuk meneliti secara mendalam faktor-faktor tersebut dengan menggunakan Teknik Kumpulan Nominal yang dikenali sebagai (NGT), iaitu satu pendekatan kualitatif yang melibatkan penyertaan pelajar dan tenaga pengajar dalam sesi diskusi berstruktur untuk mengenal pasti isu sebenar yang dihadapi [3]. Teknik ini memberikan kelebihan kerana ia menonjolkan kepelbagaian pandangan secara sistematik dan menghasilkan konsensus

II. OBJEKTIF KAJIAN

Matlamat utama penyelidikan ini adalah untuk mengkaji dan menganalisis faktor-faktor yang berkait dengan kegagalan pelajar Program Sijil Asas Tahfiz di Politeknik Sultan Azlan Shah dalam menamatkan pengajian dengan menggunakan pendekatan Teknik Kumpulan Nominal (NGT).

III. SOROTAN KAJIAN

Pelbagai penyelidikan terdahulu menekankan bahawa kejayaan pelajar tahfiz dipengaruhi oleh gabungan faktor dalaman dan luaran. Dorongan intrinsik seperti minat yang mendalam terhadap penghafalan al-Quran serta pengurusan masa yang berkesan dikenal pasti sebagai asas penting bagi mengekalkan konsistensi hafazan [4]. Pada masa yang sama, sokongan luaran seperti kemudahan institusi yang mencukupi dan dorongan emosi daripada keluarga turut menjadi faktor pengukuh dalam membantu pelajar mengatasi cabaran akademik [5].

Kajian lain turut menekankan kepentingan standard pengajaran yang berkualiti serta hubungan positif antara pendidik dan pelajar dalam mengekalkan motivasi [6]. Namun begitu, beberapa penyelidikan menunjukkan bahawa tekanan akademik yang berlebihan boleh melemahkan daya fokus dan menjejaskan pencapaian hafazan [7].

IV. PERMASALAHAN KAJIAN

Kegagalan pelajar dalam melengkapkan pengajian merupakan isu yang kerap berlaku dalam institusi pendidikan tinggi, termasuk di Politeknik Sultan

berkumpulan terhadap isu kritikal yang dikenal pasti [3].

Hasil dapatan kajian ini diharap dapat memberikan sumbangan yang signifikan kepada pihak pentadbiran PSAS dan JAKIM dalam merangka strategi penambahbaikan yang lebih berfokus kepada keperluan sebenar pelajar. Kajian ini juga menyumbang kepada pengkayaan literatur tempatan dalam bidang penyelidikan pendidikan Islam, khususnya berkaitan program integrasi diploma TVET di Politeknik Malaysia dengan Program Sijil Asas Tahfiz di institusi pendidikan tinggi Malaysia.

Matlamat khusus penyelidikan ini adalah seperti yang berikut:

1. **Mengenal pasti tema** bagi punca kegagalan pelajar Program Sijil Asas Tahfiz PSAS dalam menamatkan pengajian.
2. **Menentukan susunan keutamaan** faktor-faktor utama yang dikenal pasti sebagai penyumbang kepada kegagalan pelajar dalam menamatkan pengajian.

Sintesis daripada kajian-kajian ini menunjukkan bahawa walaupun banyak faktor telah dikenal pasti, kebanyakannya dikaji secara terpisah, sama ada menekankan aspek psikologi, sosial, atau institusi.

Oleh itu, terdapat keperluan kepada pendekatan yang dapat mengintegrasikan pandangan daripada pelbagai pihak bagi menghasilkan gambaran yang lebih menyeluruh tentang punca kegagalan pelajar. Dalam konteks ini, penggunaan Teknik Kumpulan Nominal (NGT) menawarkan kelebihan kerana membolehkan isu ditentukan mengikut keutamaan melalui penglibatan pelajar, pendidik, dan pentadbir secara serentak [8]. Dapatan yang dihasilkan melalui NGT bukan sahaja lebih holistik, tetapi juga boleh dijadikan asas dalam merangka polisi dan intervensi yang lebih tepat sasaran untuk meningkatkan prestasi serta kadar pengekalan pelajar [9].

Azlan Shah (PSAS). Fenomena ini turut dialami oleh pelajar Program Sijil Asas Tahfiz PSAS, di mana 26 daripada 38 pelajar yang mendaftar tidak berjaya menyelesaikan pengajian dalam tempoh yang ditetapkan. Isu ini memberi impak ketara

terhadap masa depan pelajar serta reputasi institusi. [10]

Pelbagai faktor boleh menyumbang kepada kegagalan pelajar, antaranya kelemahan dalam strategi pembelajaran, hubungan sosial yang rapuh, tekanan psikologi, serta persekitaran pembelajaran yang tidak kondusif [11]. Misalnya, kajian menyatakan bahawa minat dalaman dan pengurusan masa yang kurang teratur merupakan punca utama ketidakselesaian akademik dalam kalangan pelajar tahfiz [12]. Sokongan sosial daripada keluarga dan rakan sebaya serta kemudahan fizikal institusi juga memainkan peranan penting dalam prestasi akademik [13]. Sebaliknya, tekanan akademik atau beban hafazan yang tidak seimbang dengan tuntutan

akademik boleh melemahkan komitmen pelajar untuk terus bergraduasi [14].

Walau bagaimanapun, tiada kajian terdahulu yang menumpukan kepada pelajar Program Sijil Asas Tahfiz di PSAS menggunakan pendekatan Teknik Kumpulan Nominal (NGT) kerana Program Sijil Asas Tahfiz di PSAS baru diperkenalkan sekitar tahun 2022. Kaedah ini sesuai digunakan kerana ia membolehkan pengumpulan pandangan daripada pelbagai pihak, pelajar dan tenaga pengajar secara sistematik dalam mengenalpasti punca kegagalan menamatkan pengajian.

V. KAEDAH KAJIAN

Kajian ini menggunakan pendekatan kualitatif melalui Teknik Kumpulan Nominal (NGT) untuk mengenal pasti faktor kegagalan pelajar Sijil Asas Tahfiz di Politeknik Sultan Azlan Shah (PSAS). NGT dipilih kerana kaedah ini membolehkan idea individu dikumpulkan, dibincangkan, dan dipersetujui secara konsensus dalam kumpulan kecil [15].

Reka Bentuk dan Sampel Kajian

Kajian melibatkan dua kumpulan peserta: (i) lima orang tenaga pengajar program sebagai panel pakar bagi mencadangkan tema awal faktor kegagalan, dan (ii) 26 orang pelajar yang gagal menamatkan pengajian untuk menilai serta mengundi tema tersebut. Pemilihan responden dibuat secara pensampelan bertujuan agar hanya individu yang relevan dengan konteks kajian terlibat [16]– [18].

Sampel Kajian

Sampel penyelidikan ini terdiri daripada lima orang pakar yang merupakan tenaga pengajar Program Sijil Asas Tahfiz dan 26 orang pelajar yang gagal menamatkan pengajian. Pemilihan sampel ini dilakukan secara bertujuan bagi memastikan keterlibatan individu yang mempunyai pengetahuan mendalam serta pengalaman langsung berkaitan

dengan isu kegagalan pelajar dalam program tersebut. Kaedah pensampelan bertujuan lazimnya digunakan dalam penyelidikan kualitatif apabila penyelidik ingin mendapatkan maklumat daripada peserta yang benar-benar memahami konteks kajian [17], [18].

Instrumen dan Prosedur NGT

Instrumen kajian berbentuk panduan sesi NGT yang merangkumi empat fasa utama: (1) penjanaan idea, (2) penyusunan idea, (3) perbincangan dan klarifikasi, dan (4) pengundian keutamaan [19], [20]. Dalam pelaksanaan, kumpulan tenaga pengajar terlebih dahulu mengenal pasti tema awal. Seterusnya, kumpulan pelajar menilai tema tersebut melalui undian penerimaan/penolakan dan penetapan keutamaan. Keseluruhan proses difasilitasi penyelidik bagi memastikan pengumpulan data berjalan sistematik serta berpanduan prinsip NGT [21]–[24].

VI. DAPATAN KAJIAN

Berdasarkan analisis data NGT yang melibatkan 26 orang pelajar, lima tema utama telah dikenal pasti sebagai faktor kegagalan menamatkan pengajian. Jadual 1 menunjukkan tahap penerimaan kesemua tema dengan skor tinggi (85%–100%), manakala Jadual 2 pula menyusun keutamaan faktor berdasarkan jumlah skor.

Jadual 1: Dapatan Undian Tema Utama Faktor Kegagalan Pelajar Menamatkan Pengajian Program Sijil Asas Tahfiz PSAS

Bil	Tema Utama	Jumlah Skor (N=26)	Peratus (%)	Status Penilaian
1.	Faktor Pembelajaran	130	100%	Terima
2.	Aspek Institusi dan Reka Bentuk Kurikulum	110	85%	Terima
3.	Faktor Persekitaran dan Kemudahan Fizikal	112	86%	Terima
4.	Faktor Psikologi	114	88%	Terima
5.	Faktor Sosial dan Keluarga	122	94%	Terima

Jadual 2: Dapatan Undian Susunan Keutamaan Faktor Kegagalan Pelajar Menamatkan Pengajian Program Sijil Asas Tahfiz PSAS

Bil	Tema Utama	Jumlah Skor (N=26)	Peratus (%)	Susunan Keutamaan
1.	Faktor Pembelajaran	130	100%	1
2.	Aspek Institusi dan Reka Bentuk Kurikulum	110	85%	5
3.	Faktor Persekitaran dan Kemudahan Fizikal	112	86%	4
4.	Faktor Psikologi	114	88%	3
5.	Faktor Sosial dan Keluarga	122	94%	2

Faktor Pembelajaran muncul sebagai penyumbang utama dengan skor maksimum (100%), menggambarkan isu kelemahan kemahiran belajar, strategi hafazan, dan pengurusan masa sebagai cabaran paling kritikal. Dapatan ini selaras dengan dapatan awal sesi perbincangan, di mana majoriti pelajar menekankan kesukaran mengimbangi hafazan dengan subjek akademik. Seorang responden menyatakan bahawa *“banyak masa digunakan untuk mengulang hafazan sehingga subjek lain terabai”*, mengesahkan dapatan kuantitatif.

Faktor Sosial dan Keluarga berada pada kedudukan kedua (94%). Walaupun hampir semua pelajar mengakui kepentingan sokongan keluarga, beberapa peserta menekankan bahawa konflik keluarga, tekanan kewangan, dan ketiadaan sokongan moral boleh melemahkan motivasi. Dapatan ini menunjukkan pengaruh faktor eksternal yang kuat, yang kadangkala melebihi kesan institusi atau kurikulum.

Faktor Psikologi (88%) pula mencerminkan kepentingan kesejahteraan emosi, motivasi dalaman, dan daya tahan. Beberapa pelajar

menyuarakan bahawa tekanan berlebihan dalam menyiapkan hafazan menyebabkan mereka berasa *“letih mental dan hilang fokus”*. Triangulasi dapatan ini dengan pengamatan fasilitator semasa sesi NGT menunjukkan bahawa isu psikologi sering muncul berulang kali walaupun tidak mendominasi skor tertinggi.

Faktor Persekitaran dan Kemudahan Fizikal (86%) berada di kedudukan keempat. Walaupun tidak dianggap dominan, pelajar tetap menegaskan bahawa kekurangan ruang belajar kondusif dan akses sumber rujukan moden menyukarkan mereka. Isu ini cenderung timbul dalam bentuk rungutan praktikal, misalnya tempat tinggal asrama yang bising atau kekurangan ruang ulangkaji.

Akhir sekali, Aspek Institusi dan Reka Bentuk Kurikulum memperoleh skor paling rendah (85%), namun masih signifikan. Pelajar berpendapat struktur kurikulum yang padat dan kurang fleksibel menjejaskan keseimbangan antara hafazan dan akademik. Walaupun faktor ini dilihat kurang berkesan secara langsung berbanding pembelajaran sendiri atau sokongan keluarga, ia tetap memberi kesan kumulatif terhadap prestasi keseluruhan.

Secara keseluruhannya, dapatan ini menunjukkan bahawa faktor dalaman (pembelajaran, psikologi) dan faktor sokongan sosial lebih dominan berbanding aspek luaran seperti infrastruktur dan institusi. Analisis triangulasi antara undian skor,

VII. PERBINCANGAN DAN RUMUSAN

Dapatan kajian ini mendedahkan lima faktor utama yang menyumbang kepada kegagalan pelajar menamatkan pengajian dalam Program Sijil Asas Tahfiz di Politeknik Sultan Azlan Shah (PSAS). Melalui pelaksanaan Teknik Kumpulan Nominal (NGT), hierarki keutamaan faktor telah dikenal pasti secara konsensus, memberikan asas yang kukuh untuk merangka intervensi yang lebih berfokus.

Faktor pembelajaran muncul sebagai penyumbang dominan. Dapatan ini bukan sahaja selari dengan Awang dan Daud [25] yang menegaskan kelemahan kemahiran belajar dan pengurusan masa sebagai halangan utama, malah ia menonjolkan keperluan kepada sokongan pedagogi yang lebih sistematik. Oleh itu, intervensi yang disyorkan termasuk pelaksanaan bengkel kemahiran belajar berasaskan hafazan, penggunaan teknologi pembelajaran interaktif, serta sistem pemantauan akademik secara berkala bagi membantu pelajar menyesuaikan diri dengan keperluan gabungan akademik dan hafazan [26].

Faktor sosial dan keluarga turut memberi kesan signifikan, khususnya apabila wujud konflik nilai atau ketiadaan sokongan moral. Walaupun selari dengan Norasmah et al. [27], dapatan ini menuntut pendekatan intervensi seperti program libat urus keluarga, bimbingan keibubapaan, dan sokongan komuniti bagi memastikan kesejahteraan emosi pelajar lebih terjamin.

Dari sudut psikologi, tekanan emosi dan keyakinan diri yang rendah terbukti menjejaskan motivasi. Seperti yang dijelaskan Yusoff [28], tanpa intervensi kaunseling, risiko

perbincangan NGT, dan pandangan pelajar memperkukuh kesimpulan bahawa kegagalan pelajar adalah multidimensi, dengan pembelajaran sebagai faktor paling kritikal, namun dipengaruhi secara signifikan oleh konteks sosial dan psikologi.

keciciran meningkat. Sehubungan itu, institusi disaran memperkukuh sistem kaunseling dengan menyediakan modul pembangunan diri berasaskan nilai Islam serta mewujudkan mentor akademik yang boleh memantau kesejahteraan pelajar secara berterusan.

Bagi faktor persekitaran dan kemudahan fizikal, isu seperti kekurangan ruang belajar dan peralatan sokongan menjejaskan keberkesanan pembelajaran. Walaupun Hassan et al. [29] menekankan kepentingan infrastruktur, dapatan ini menunjukkan bahawa strategi konkrit perlu dilaksanakan, antaranya penyediaan makmal tahfiz berteknologi, ruang hafazan kondusif, dan akses sumber digital yang lebih luas.

Akhir sekali, aspek institusi dan kurikulum turut memberi kesan apabila kurikulum kurang fleksibel dan pemantauan akademik tidak menyeluruh. Selari dengan cadangan Zainudin dan Ghazali [30], institusi perlu melaksanakan kurikulum integrasi yang lebih adaptif, menggabungkan pendekatan hafazan tradisional dengan pedagogi moden berasaskan TVET, serta mewujudkan mekanisme maklum balas pelajar untuk penambahbaikan berterusan.

Secara keseluruhan, perbincangan ini menunjukkan bahawa faktor kegagalan pelajar adalah multidimensi dan saling berkait. Oleh itu, intervensi yang menyeluruh melibatkan pengukuhan pedagogi, sokongan keluarga, pembangunan psikologi, penyediaan infrastruktur kondusif, dan penambahbaikan kurikulum diperlukan untuk meningkatkan kadar pengekalan pelajar. Analisis kritikal ini menegaskan bahawa keberkesanan program tahfiz hanya dapat dipertingkatkan melalui pendekatan holistik yang menyatukan usaha

pensyarah, pentadbir, keluarga, dan pihak institusi [31].

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Application of Box-Jenkins Models for Forecasting Global Rubber Market Trends

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Abstract

Global rubber prices are subject to fluctuations influenced by market demand, supply dynamics, and economic factors, making accurate forecasting essential for producers, traders, and policymakers. This study aims to apply the Box–Jenkins ARIMA model to forecast monthly global rubber prices from October 2021 to April 2025 and evaluate the forecasting performance. Monthly rubber price data from the Federal Reserve Economic Data (FRED) database, covering the period from January 1990 to April 2025, were analysed, with the dataset split into 90% for training and 10% for testing. Two models, ARIMA(0,1,1) and ARIMA(1,1,0), were developed and compared based on forecasting accuracy using Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE). Results indicate that ARIMA(0,1,1) provided slightly better accuracy (MAE = 15.82, RMSE = 18.70, MAPE = 16.83%) than ARIMA(1,1,0), suggesting that ARIMA(0,1,1) produces good predictions for short-term projections of global rubber prices. These projected results may offer useful insights for Malaysia, as one of the world's leading natural rubber exporters, in guiding trade planning, supporting risk management, and informing future strategies. Future research could integrate volatility models, exogenous economic variables, or hybrid approaches to strengthen predictive performance and enhance the practical relevance of modelling outcomes.

Keywords : *Arima Model; Box-Jenkins; Global Rubber Price; Time Series Analysis*

I. INTRODUCTION

Natural rubber is vital for industries such as automotive tyres, industrial goods, and medical equipment, making price volatility a critical concern for producers, manufacturers, and policymakers. Since 2020, commodity markets have faced sharp fluctuations, with the World Bank reporting both short-term shocks and persistent drivers of volatility [1]. Accurately forecasting these fluctuations remains a challenge, particularly for natural rubber prices, which require precise model specification and transparent communication of uncertainties [2], [3], [4], [5].

The Box–Jenkins Autoregressive Integrated Moving Average (ARIMA) framework provides a structured and interpretable approach for univariate forecasting, consisting of four stages: model identification, parameter estimation, diagnostic checking, and forecasting [6], [7], [8]. While contemporary reviews increasingly compare ARIMA with machine learning and hybrid methods, ARIMA remains a robust and interpretable benchmark for practical applications [9]. Recent studies conducted after 2020 on rubber and other commodities have highlighted the applicability of ARIMA, while also underscoring its limitations

when exposed to market shocks and variance shifts.[10].

This study employs the Global Price of Rubber (PRUBBUSDM) monthly series from the Federal Reserve Bank of St. Louis (FRED), a publicly available dataset with well-documented sources [11], [12], [13]. Forecasting guidelines recommend reporting prediction intervals alongside point forecasts to capture uncertainty, while recent applications of deep learning highlight potential gains depending on data and horizon [14]. Within this broader modelling landscape, ARIMA continues to serve as a standard reference [15], [16]. The objective of this study is to apply the Box–Jenkins ARIMA approach to forecast monthly global rubber prices from October 2021 to April 2025 and to assess the forecasting accuracy of the model.

II. LITERATURE REVIEW

Forecasting commodity prices has been studied using a wide range of methods. The Box-Jenkins ARIMA framework remains one of the most widely applied and interpretable approaches, while alternatives such as state-space models, hybrid statistical-machine learning methods, and deep learning models have been introduced to address

nonlinearity, structural breaks, and volatility. Comparative studies show that no single method consistently outperforms others, with accuracy often depending on the forecasting horizon and dataset characteristics. In agriculture and food markets, frequent shocks and regime changes complicate forecasting, making transparency, out-of-sample testing, and uncertainty communication essential.

In the context of rubber and other agri-commodities, ARIMA often serves as the benchmark for univariate forecasting. In India, the Box-Jenkins methodology was applied to weekly RSS-1 prices, selecting ARIMA(1,1,4) as the optimal specification [10]. Research in Malaysia using monthly SMR 20 data reported ARIMA(1,1,0) as the best-fitting model [17]. Further analysis of Indian rubber series, including RSS 4, Latex 60% DRC, and ISNR 20, found ARIMA(3,1,2) and ARIMA(4,1,3) to be suitable, depending on the series [18]. A study conducted in Thailand compared ARIMA and ARIMAX models and found that ARIMAX(0,1,1), which included external variables, achieved higher accuracy with a MAPE of 1.11% [19]. At the international level, the application of the SARIMA model to TOCO's RSS 3 series successfully captured both trend and seasonality in global rubber prices [20].

While ARIMA models have been widely applied in rubber price forecasting, most prior studies have focused on shorter data spans or national markets [21]. By contrast, relatively few studies have systematically applied the Box-Jenkins ARIMA methodology to long-run monthly global rubber price data, which motivates the present study.

III. DATA AND METHODOLOGY

A. Data Description

This study utilises the monthly Global Price of Rubber time series from Federal Reserve Economic Data (FRED), series code PRUBBUSDM, Global Price of Rubber, expressed in U.S. dollars per metric ton (US\$/MT). The dataset covers the period from January 1990 to April 2025, consisting of 424 monthly observations. Exploratory data analysis (EDA) was first conducted to identify potential anomalies and understand the overall trend and seasonality. The dataset was divided into a 90% training set (January 1990 to September 2021) for model development and a 10% testing set (October 2021 to April 2025) for model validation.

B. ARIMA Model Development

The modelling follows the Box-Jenkins methodology, which has four stages: model identification, parameter estimation, diagnostic checking, and forecasting. The general framework is illustrated in Figure 1.

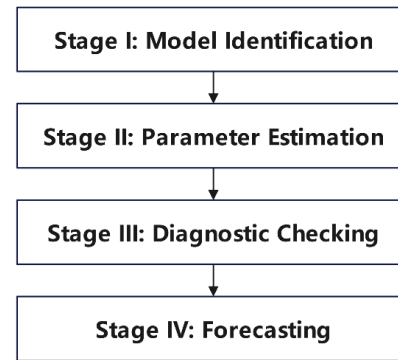


Figure 1: General framework of Box-Jenkins modelling [22]

In the first stage, the series is examined for stationarity in variance and mean. A Box-Cox transformation was applied to stabilise the variance [23]. The formula of the Box-Cox transformation for positive series, $y_t > 0$ is given in Equation 1.

$$y_t^* = \begin{cases} \frac{y_t^\lambda - 1}{\lambda}, & \lambda \neq 0 \\ \log_e(y_t), & \lambda = 0 \end{cases} \quad \text{Equation 1}$$

Mean stationarity is assessed using time plots, the sample autocorrelation function (ACF), the partial autocorrelation function (PACF), and the Augmented Dickey-Fuller (ADF) unit-root test [24]. If nonstationarity is detected, nonseasonal differencing is applied until stationarity is achieved. Once the appropriate differencing order d is determined, the general ARIMA(p, d, q) model can be expressed as Equation 2.

$$\phi(B)(1-B)^d y_t = \theta(B)\varepsilon_t \quad \text{Equation 2}$$

where $\phi(B) = 1 - \phi_1 B - \dots - \phi_p B^p$ is the autoregressive operator, $(1-B)^d$ represents differencing of order d , $\theta(B) = 1 + \theta_1 B + \dots + \theta_q B^q$ is the moving average operator, and ε_t is the white noise term.

Stage II of the Box-Jenkins method estimates the autoregressive (AR) and moving average (MA) parameters of the ARIMA model. Parameters are obtained using least squares or maximum likelihood estimation (MLE). Model fit is

then evaluated with the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC), where lower values indicate a better-fitting model [25], [26].

Stage III of the Box–Jenkins method involves diagnostic checking to verify model adequacy. Residuals are examined using the ACF and the Ljung–Box Q test to ensure that no significant autocorrelation remains [27]. A model is considered adequate when residuals resemble white noise, indicating that the systematic structure of the series has been captured. If the diagnostics suggest inadequacy, alternative model specifications are considered.

Stage IV is forecasting, where the validated model is used to generate future values of the series. Forecast performance is assessed by comparing predicted values against the testing dataset using accuracy measures such as Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE) as in Equations 3, 4, and 5. The interpretation of MAPE follows Lewis [28], as shown in Table 1.

$$MAE = \frac{1}{n} \sum_{t=1}^n |Y_t - \hat{Y}_t| \quad \text{Equation 3}$$

$$RMSE = \sqrt{\frac{1}{n} \sum_{t=1}^n (Y_t - \hat{Y}_t)^2} \quad \text{Equation 4}$$

$$MAPE = \frac{1}{n} \sum_{t=1}^n \left| \frac{Y_t - \hat{Y}_t}{Y_t} \right| \times 100 \quad \text{Equation 5}$$

Table 1: Interpretation of typical MAPE [28]

MAPE(%)	Evaluation
<10%	High accuracy prediction
10%-20%	Good prediction
20%-50%	Reasonable prediction
>50%	Inaccurate prediction

IV. RESULTS AND DISCUSSION

The monthly global rubber price from January 1990 to April 2025 exhibited significant fluctuations, with values ranging from about 25 US\$/MT in the early 2000s to a peak exceeding 260 US\$/MT in 2011, as shown in Figure 2. A gradual increase in prices is visible during the mid-1990s, followed by cycles of rises and declines throughout the 2000s. The most significant increase was observed between 2009 and 2011, likely associated with the global economic recovery after the financial crisis, followed by a marked decline from 2012 onwards. More recently, the series displays recurring volatility with moderate rebounds, which is consistent with the broader volatility observed in commodity markets.

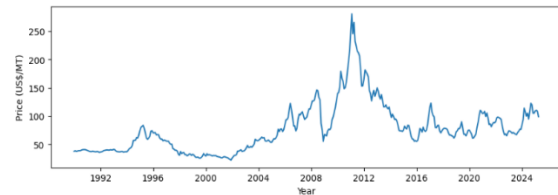


Figure 2: Time series plot of global rubber price

The series was split 90:10, with the training dataset covering January 1990 to September 2021 and the testing dataset covering October 2021 to April 2025. Variance stationarity on the training dataset was checked, yielding $\lambda = -0.2018$. Accordingly, Box–Cox was applied to stabilise the variance. Mean stationarity was then assessed using an ACF and PACF plot, and the ADF test was used to check stationarity. Figure 3 displays the ACF and PACF plots for the Box–Cox transformed training series. The ACF decays slowly, while the PACF shows a single dominant spike at lag 1 shows the series is not stationary in mean. The ADF test confirms with an ADF statistic was -1.784 with $p = 0.388 (> 0.05)$, indicating the series is not stationary in mean, hence first differencing is needed, $d = 1$. The ADF test on the first-differenced Box–Cox series ($ADF = -15.00$, $p < 0.01$) rejects the null of a unit root, confirming stationarity with values fluctuating around zero as shown in Figure 4.

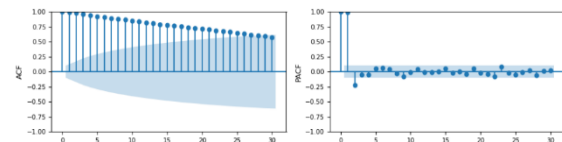


Figure 3: ACF and PACF plot for transformed series

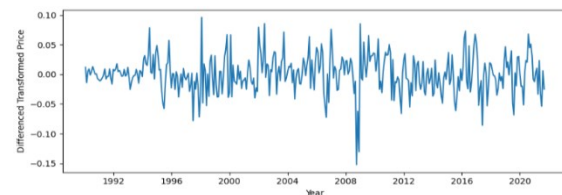


Figure 4: Time series plot after transformation and first differencing

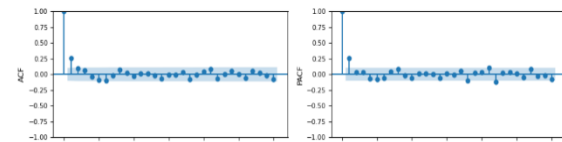


Figure 5: ACF and PACF plots after transformation and first differencing

The ACF and PACF of the transformed and differenced series are shown in Figure 5. The ACF shows a sharp drop after lag one, while the PACF

has a significant spike at lag one and then decays. These features suggest that low-order terms with $p = 1$ and $q = 1$ may be appropriate for the ARIMA model. Therefore, tentative models such as ARIMA(1,1,0) and ARIMA(0,1,1) will be evaluated further to identify the optimal order. Table 2 presents the results of ARIMA(1,1,0) and ARIMA(0,1,1) model analysis for forecasting the global rubber price.

Table 2: Tentative models of ARIMA

ARIMA Model	Parameter Estimation	AIC	BIC
(0,1,1)	$\phi = 0.2319(0.000)$	-1574	-1566
(1,1,0)	$\phi = 0.2521(0.000)$	-1577	-1569

Based on Table 2, ARIMA(1,1,0) recorded the lowest AIC and BIC values; however, the difference compared to ARIMA(0,1,1) was not statistically significant. Both models were therefore considered for further evaluation, and the Ljung-Box test results ($p > 0.05$) indicated no significant autocorrelation in the residuals. The model performance was then assessed using MAE, RMSE, and MAPE on the testing dataset. As shown in Table 3, both models produced comparable results with ARIMA(0,1,1) demonstrating slightly better performance. Therefore, ARIMA(0,1,1) was selected as the final model to forecast monthly global rubber prices, and the forecasting performance from October 2021 to April 2025 is illustrated in Figure 6.

Table 3: Model performance comparison

Model	MAE	RMSE	MAPE
ARIMA(0,1,1)	15.82	18.70	16.83%
ARIMA(1,1,0)	15.88	18.85	16.83%

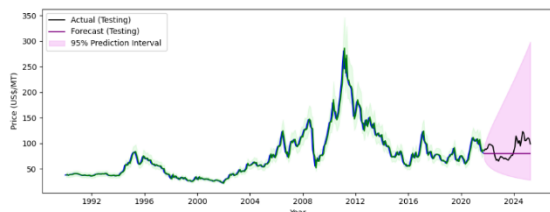


Figure 6: Forecast of global rubber prices in US dollars per metric ton using the ARIMA(0,1,1)

The forecasts are stable around 100 US dollars per metric ton, although the prediction intervals widen towards the end of the horizon. This widening reflects growing uncertainty in long-term forecasts, which is common in volatile commodity markets, and it underlines the need for careful planning to manage potential risks in trade and pricing strategies. The stable outlook suggests no major short-term disruptions in supply and demand,

but the broader range indicates vulnerability to shocks such as oil price fluctuations, global demand shifts, or trade policy changes. For Malaysia, as a key rubber exporter, these forecasts provide valuable input for trade negotiations, export planning, and risk management.

V. CONCLUSION

This study applied the Box–Jenkins ARIMA methodology to forecast monthly global rubber prices from October 2021 to April 2025, and the findings show that ARIMA(0,1,1) achieved slightly better predictive accuracy than ARIMA(1,1,0), producing reliable short-term forecasts. The widening prediction intervals towards the end of the horizon highlight the uncertainty of long-term projections, which is common in volatile commodity markets. A limitation of this study is that it uses a univariate model, which does not account for external factors such as crude oil prices, exchange rates, and global demand changes. From a business and policy perspective, these forecasts can serve as a useful reference for Malaysia as one of the world’s leading natural rubber exporters. Policymakers may take these projected results into account when designing trade policies, preparing for potential market risks, and supporting evidence-based planning. Industry stakeholders, including producers and traders, may also rely on the modelling outcomes to guide production planning, inventory management, and risk assessment. Future research may address current limitations by incorporating external variables and applying volatility models, or hybrid approaches, which could improve predictive accuracy and make rubber price forecasting more relevant for policy and decision-making.

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The Effectiveness of Industrial Training in Developing the Professionalism Among Civil Engineering Students, Polytechnic Sultan Mizan Zainal Abidin

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Abstract

This study explores the effectiveness of industrial training in enhancing the professionalism of civil engineering students. Industrial training plays a vital role in bridging the gap between academic learning and real-world industry practice, particularly in engineering education. In the context of civil engineering, where practical skills and professional conduct are crucial, industrial training serves as a platform for students to develop essential professional qualities such as ethical responsibility, effective communication, teamwork, and leadership. The purpose of this study is to evaluate the effectiveness of industrial training in developing professionalism among civil engineering students in Polytechnic Sultan Mizan Zainal Abidin, Dungun Terengganu. Specifically, it aims to assess the impact of industrial training on student's professional growth, identify the challenges they face during the training period and proposed suggestions for improvement. This study uses a quantitative method through a questionnaire distributed to 73 Civil Engineering Diploma students who completed their industrial training during Session I:2024/2025 and Session II:2024/2025. The finding of the study is categorized into three main aspects: industrial training experience, development of professionalism and challenge during industrial training. For the industrial training experience, the average mean and standard deviation obtain is 4.375 and 0.777 This indicates that respondents strongly agree with positive statement about the training experience, and the relatively low standard deviation suggest consistency in their responses. In terms of professional development also, the average mean and standard deviation is 4.539 and 0.682 where it indicates that the most respondents agreed or strongly agreed with the positive statement about professional development in industrial training. As for challenge during industrial training, the average score mean was 2.349 with a standard deviation of 1.219. While most students reported positive experience, the higher standard deviation indicates variability in responses, suggesting that some students did encounter difficulties. Based on the findings obtains, it shows that the industrial training is effective in developing the professionalism among civil engineering diploma students.

Keywords : *Industrial Training, Professionalism, Civil Engineering Students*

I. INTRODUCTION

Industrial training is an essential component of technical and professional education, particularly within civil engineering programmes. It bridges academic learning with practical industry exposure, offering students valuable experience in real workplace settings and enabling them to apply theoretical knowledge in practical, real-life situations. In a competitive and globalised job market, professionalism, including work ethics,

communication skills, teamwork and social responsibility, plays a vital role in the employability and long-term success of graduates. Industrial training offers considerable potential for developing these professional qualities and preparing students to become versatile civil engineers. By engaging in real-world engineering projects, students gain hands-on experience that strengthens their technical expertise, problem-solving capabilities, and overall professional competence, skills that are critical for their future careers in civil engineering field.

Professionalism in civil engineering goes beyond technical competence; it encompasses ethical considerations, workplace communication, teamwork, and adaptability to industry demands. Employers increasingly seeking graduates who demonstrate not only academic excellence but also the ability to work effectively in a professional environment. Industrial training provides students with an important platform to familiarize themselves with industry standards, and collaborative project management practices.

Industrial training also presents challenges, including placement availability, variation in training quality, and alignment between academic curricula and industry expectations. Some students experience difficulties in transitioning from classroom learning to practical applications, underscoring the need for well-structured training programs with adequate mentorship and evaluation mechanisms.

This research aims to assess the effectiveness of industrial training in developing the professionalism among civil engineering students. The study examines students' perspectives, to determine how training programs contribute to professional development. By analysing key factors such as industrial training experience, development of professionalism and challenges during industrial training.

II. PROBLEM STATEMENT

Civil engineering graduates are expected to demonstrate a high standard of professionalism, encompassing ethical behaviour, effective communication, teamwork, leadership, and adaptability in dynamic work environments. These competencies are crucial for career readiness and long-term success in the industry. Industrial training has long been integrated into engineering curricula as a means of bridging the gap between theoretical knowledge and practical application. It is assumed to be a key vehicle for developing professionalism among engineering students by exposing them to real-life work conditions and industry expectations. However, are placed in roles unrelated to their field, perform repetitive tasks, or lack proper guidance resulting in limited professional growth. This study, therefore, seeks to address this gap by systematically examining the effectiveness of industrial training in developing professionalism among civil engineering students.

Professionalism is a fundamental requirement in civil engineering, encompassing technical expertise, ethical responsibility, teamwork, and communication skills. Employers and industry professionals emphasize the importance of

graduates being well-prepared for employment, combining theoretical knowledge with practical experience. However, many civil engineering encounters difficulties in the transition from university studies to professional world, raising concern about their readiness for the demands of the industry.

Industrial training is designed to bridge this gap by providing students with hands-on experience in real-world projects. While these programs aim to enhance technical competencies and workplace adaptability, the extent to which they effectively shape students' professionalism remains unclear. Some students report significant benefits in terms of skill development and confidence, whereas others struggle with inadequate mentorship, misalignment between academic curricula and industry expectations, and limited exposure to essential professional practices.

Additionally, variations in industrial training quality, placement accessibility, and duration contribute to inconsistent learning outcomes. Without a structured approach to evaluating the effectiveness of these programs, educational institutions and industry stakeholders face difficulties in refining training methodologies to maximize students' professional growth. This study seeks to evaluate the effectiveness of industrial training in developing the professionalism among civil engineering students by examining their experiences, industry perspectives, and training frameworks. The research aims to identify key factors influencing professional development, explore challenges faced during training, and propose improvements to enhance future training programs.

III. LITERATURE REVIEW

Industrial training (also referred to as internship or practicum) is a form of **experiential learning** that enables students to gain practical insights into real-world working environments. Industrial training is structured learning off campus learning program that offers students the opportunity to gain practical experience in a professional environment before entering the workplace [1].

Internships and cooperative education experiences are regarded as "high impact practices in higher education". From the industry's viewpoint, internships are highly valued, with research demonstrating that employers prefer candidates who have completed work-based internships or placement when selecting talent during recruitment [2]. Internships offer engineering students valuable opportunities to acquire a broad range of knowledge

and skills. However, workplace learning is naturally less structured and more unpredictable than traditional classroom-based education [3].

The emergence of artificial intelligence in the workplace, along with intense competition workforce, has prompted significant concerns regarding the future of work and the capacity of undergraduate academic programs to adequately prepare students for this rapidly evolving and demanding environment [4].

Although the benefits of internships particularly the development of technical and soft skills are widely acknowledged, higher education institutions should actively manage and enhance the effectiveness of their internship programs to ensure positive learning outcomes for interns. For such a purpose, it is imperative to evaluate the quality of engineering internships in order to identify opportunities for enhancing their design and implementation [5].

Civil engineering education at universities must continuously evolve to ensure are well-prepared for a dynamic and ever-changing industry. Employers increasingly need diverse skills, including the skills that graduates will need in a few years' time that cannot even be conceived yet [6].

The internship program provides students with the opportunity to understand how theoretical concepts are applied in real-world situations. Since industries tend to favor hiring graduates with practical training experience, internship program helps students secure employment more quickly. Most of the academic institutions, giving a due recognition to the internship programmes, are now tends to incorporate an internship component to their academic curricular [7].

It is a common belief in the Malaysian construction industry that training is essential if the performance improvement of the construction workforce is to be achieved. This emanates from the conviction that training lies at the core of creating, maintaining, and developing the construction workforce, who contribute significantly to the achievement of construction projects [8].

The significance of employability skills in the engineering sector is more critical now than ever before. Most engineering industries utilise advanced equipment, complex system, and systematic processes, demanding engineers who are highly trained, versatile, and multi-skilled. Employers need an engineer with a solid theoretical background and equipped with essential soft skills and employability skills [9].

Educational goals proposed at the end of the 20th century such as "returning to engineering practice,"

"embracing the shift in the engineering education paradigm," and "reengineering engineering education" reflected an increasing international trend toward innovative engineering education. In the context of school enterprise collaboration, it is essential to provide on-site practical opportunities for students, allowing them to spend approximately a year learning within an enterprise environment. Such programs should include companies assigning experienced engineers as instructors and facilitating student involvement in operations, technological innovation and engineering development [10].

Industrial training offers a wide range of benefits, with the most significant being its ability to provide students with the opportunity to apply their academic knowledge and skills in real-world work environments. Moreover, it also provides chances for students to learn from practitioners in their respective fields [11].

In civil engineering, industrial training allows students to engage with tasks related to construction, structural design, site supervision, project management, and workplace safety—bridging the gap between classroom theory and industry practice. Professionalism in engineering encompasses a broad range of competencies, including Work ethics (discipline, integrity, accountability), Communication skills (oral, written, technical reporting), Teamwork and collaboration, Leadership and time management, Critical thinking and problem-solving. The industrial training programme refers to exposure to real working environment that contributes to students' professional development prior to graduation and supports their future employability. It is an essential element in the development process of professional skills and work ethics required to become an engineer [12].

As Malaysia moves towards becoming a developed country, graduates are expected have excellent academic achievement and skills before entering an increasing challenging real working world. A curriculum structure which integrates knowledge, work experience, human skill, and technical skill is needed to ensure that universities produce graduates with excellent qualification [13].

Furthermore, [14] emphasize that industrial training enables students to understand professional expectations, communication protocols, and teamwork dynamics in engineering organizations. Their study found that students who participated in well-structured training programs demonstrated higher confidence levels and better adaptability to workplace challenges compared to those who relied solely on classroom education.

Engineers who have recently entered the industry are often not adequately prepared for the workforce due to lack of essential non-technical skills. One of the contributing factors is the limited industry exposure they receive during their industrial training as undergraduates [15]. The integration of soft skills and employability skills into the curriculum of every field of study is crucial for enhancing the quality of graduates in educational institutions. One effective approach to achieving this is through industrial training or industrial attachment programs [16]. Industrial training must be well-organized to ensure that engineering students acquire optimal professional skills and practical experience that can be effectively applied in the workplace upon graduation. Industrial training aims to develop the skills required by the industry and plays a crucial role in producing a skilled and professional workforce for the future [17].

According to the Board of Engineers Malaysia (BEM), today's engineers are increasingly assessed not only for technical expertise but also for their ability to function professionally within multidisciplinary teams and high-pressure environments.

However, the effectiveness of training is highly dependent on several factors, including Quality of supervision provided by industry mentors, Duration and relevance of tasks assigned, Degree of alignment between training activities and academic coursework, Level of support and monitoring provided by educational institutions. Common issues reported in previous studies include Placement of students in companies unrelated to their field of study, Insufficient mentoring and feedback from industry supervisors, short training duration that limits skill development opportunities. This study builds upon existing literature and seeks to examine the issue within a local context, specifically focusing on civil engineering students in Polytechnic Sultan Mizan Zainal Abidin.

IV. RESEARCH METHODOLOGY

A. Research Design

This study used a descriptive quantitative approach, utilizing a questionnaire as the primary tool for data collection. The questionnaire was distributed to respondents through google form to ensure accessibility and convenience. It is divided into FOUR sections: Respondent Demographic, Industrial Training Experience, Development of Professionalism and Challenge During Industrial Training.

B. Research Sample

The sample involved in this study is Civil Engineering students who have completed industrial training. The students sample consists of two industrial training sessions, namely Session I:2024/2025, Session II:2024/2025.

C. Data Analysis

The study items were measured using scores based on the Likert Scale. The data was analysed using Statistical Package for Social Science (SPSS) version 27.0 to calculate the mean score and standard deviation. These values were used to interpret the effectiveness of industrial training in developing the professionalism among civil engineering students, Polytechnic Sultan Mizan Zainal Abidin.

Table 1: Score Mean Interpretation

Score Mean	Interpretation
1.00 – 2.33	Low
2.34 – 3.66	Moderate
3.67 – 5.00	High

V. RESEARCH FINDINGS AND DISCUSSION

A. Respondent Demography

Table 2: Respondent Demography

Item	Sub-Item	Frequency (f)	Percentage (%)
Gender	Male	41	56
	Female	32	44
Organization	Government	16	22
	Private	46	63
	Construction Firm		
	Consultancy Firm	11	15

B. Effectiveness of Industrial Training in Developing Professionalism Among Civil Engineering Students

Table 3 : Industrial Training Experience

Bil	Item	Mean	Sd
1	The tasks assigned were related to civil engineering	4.342	0.869
2	Always given meaningful responsibilities during training	4.315	0.779
3	Supervisor provided sufficient guidance	4.369	0.772
4	Always exposed to real work situations in civil engineering projects	4.397	0.777

5	Training duration was adequate for gaining experience	4.452	0.688
Average		4.375	0.777

Table 3 above shows the item of industrial training experience. The first item assesses the task assigned were related to civil engineering where the mean obtained is 4.342 and 0.869 standard deviation. It means that the tasks they did were relevant to their field, indicating good alignment with academic knowledge. Second item is about the responsibilities during training where the mean and standard deviation obtain is 4.315 and 0.779. It indicates the respondents felt they were frequently assigned meaningful work, which is important for engagement and learning. The third item is supervisor provided the sufficient guidance where the mean obtain is 4.369 with 0.772 standard deviation. It indicates the strong agreement among respondents that supervisors gave enough guidance. For the fourth item, industrial training always exposed to real work situations in civil engineering projects, the mean and standard deviation value is 4.397 and 0.777 where it indicates the respondents experienced hands-on, practical work, a key factor in training relevance. The last item assess is training duration where the mean and standard deviation is 4.452 and 0.688. It indicates that the respondent felt the training duration was sufficient to gain the necessary skills and experience. For overall average mean value, it indicates that the respondents strongly agree with positive statement about the training experience while average standard deviation also indicates that the good consistency in responses across all this item.

Table 4 : Development of Professionalism

Bil	Item	Mean	Sd
1	Can improved time management during industrial training	4.547	0.601
2	Can learned to communicate effectively with team members and clients	4.534	0.668
3	Can developed a better understanding of workplace ethics and discipline	4.602	0.639
4	Can learned to work collaboratively in teams	4.561	0.686
5	Training experience made more confident to work as a professional engineer	4.452	0.817
Average		4.539	0.682

Table 4 above shows the result of the development of professionalism to respondents. According to the results, first item is assessed the improvement of time management during industrial training where

the mean score was 4.547 with a standard deviation of 0.601. This shows that most respondent felt that their time management has improved. The second item assessed effective communication with team members and clients where the mean was 4.534 and the standard deviation was 0.668. This shows that effective communication is a clear result. The third item developed a better understanding of workplace ethics and discipline in the workplace where the mean score was 4.602 with a standard deviation of 0.639. This data shows that students have better understanding of workplace ethnicity and discipline. For the fourth item which was learned to work collaboratively in a team, the mean value obtained was 4.561 with a standard deviation of 0.686. This shows that teamwork skills among civil engineering students have increased significantly. The fifth item assesses the training experience make more confident to work as a professional engineer where the mean and standard deviation obtained are 4.452 and 0.817. This shows that the training can increase the confidence of civil engineering student to work as a professional engineer. Overall, for this item shows a mean value above 4.40 which shows that most respondents agreed or strongly agreed with the positive statement about professional development in industrial training.

C. Challenges Faced During Industrial Training

Table 5 : Challenges During Industrial Training

Bil	Item	Mean	Sd
1	Tasks not aligned with academic background	2.534	1.225
2	Not receive enough supervision during training	2.301	1.265
3	Not given opportunities to participate in meaningful work	2.219	1.181
4	Not enough training period to gain sufficient experience	2.342	1.204
Average		2.349	1.219

The above Table 5 shows the item of challenges during industrial training. The first item assessed was tasks that were not aligned with the academic background where the mean value is 2.534 with a standard deviation of 1.225 which indicates that the tasks were generally aligned with civil engineering background. For the second challenge is student did not receive sufficient supervision during training where the mean was 2.301 with a standard deviation of 1.265 which means that most respondent did not receive sufficient supervision. For third item, not being given the opportunity to participate in meaningful work, the mean obtained was 2.219 with a standard deviation of 1.181. This means that many respondents felt involved in meaningful work. For item the training period was insufficient, the mean obtain was 2.342 with a standard deviation of 1.204 which means that the training duration was generally

sufficient for civil engineering student. Overall, the average mean value showed that the respondents generally disagreed or were neutral toward the negative statement.

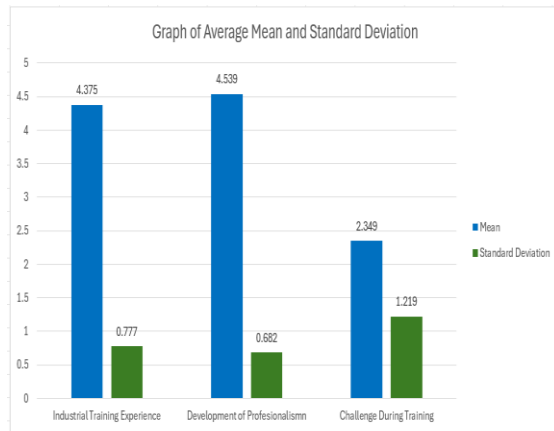


Figure 1: Graph of Average Mean and Standard Deviation

Figure 1 above shows the average mean and standard deviation graph for the effectiveness of industrial training among civil engineering students. For the items industrial training experience and professionalism development, the average mean value shows that the respondents strongly agree with positive while the average standard deviation shows good consistency in responses across all this item. For the item challenge during training, the average mean is 2.349 and 1.219 standard deviation which means that the respondents generally disagreed or were neutral toward the negative statement.

VI. CONCLUSION

This study examined the effectiveness of industrial training in developing the professionalism among civil engineering students in terms of industrial training experience, development of professionalism and challenge during industrial training. The findings affirm that the industrial training provides positive experience for civil engineering student in terms of task assigned, students always given meaningful responsibilities during training, supervisor provided sufficient guidance, always exposed to real work situation in civil engineering and adequate training duration for gaining experience. For development of professionalism also, most respondents agreed or strongly agreed with the positive statement about professional development in industrial training. For the challenges during industrial training, most respondents felt their training experience was positive. A value of standard deviation indicates that although most of respondents agree, there is some variation where that there are also some individuals who may face this challenge. The data obtained also indirectly shows that the selection of an industrial

training place is important so that students gain industrial training experience according to their field of study. For the challenge during industrial training, the data shows that some respondents may face this challenge. Therefore, to overcome this issue such as not being aligned with academic background, students need to choose a right place for industrial training. Institutions also need to ensure that students choose the right and appropriate industrial training place according to field so that students get the appropriate experience in the field of civil engineering.

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PEMBANGUNAN DAN PENAMBAHBAIKAN *ADVANCE WIND TURBINE TRAINER 2.0* SEBAGAI ALAT BANTU MENGAJAR KURSUS DEG30013 FUNDAMENTAL OF RENEWABLE ENERGY

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Abstract

Inovasi dalam bidang Pendidikan Teknikal dan Latihan Vokasional (TVET) memainkan peranan penting dalam meningkatkan kualiti proses pengajaran dan pembelajaran, khususnya dalam bidang teknologi hijau dan tenaga boleh diperbaharui. Kajian ini memfokuskan kepada pembangunan dan penambahbaikan *Advance Wind Turbine Trainer 2.0*, iaitu sebuah alat bantu mengajar (ABM) yang direka khas untuk menyokong pelaksanaan kursus DEG30013 – *Fundamental of Renewable Energy* di Politeknik Sultan Haji Ahmad Shah. Berbanding versi terdahulu yang hanya menyokong penggunaan satu jenis turbin, versi 2.0 telah ditambah baik dengan keupayaan untuk menggunakan dua jenis turbin berbeza, iaitu turbin angin jenis menegak (*vertical axis*) dan mendatar (*horizontal axis*), secara bergantian mengikut keperluan pembelajaran. Selain itu, sistem ini turut dilengkapi dengan komponen sokongan seperti sistem penyimpanan tenaga (bateri), inverter, dan beban sebenar seperti lampu untuk mensimulasikan penggunaan tenaga. Penambahbaikan ini bertujuan mewujudkan simulasi sistem tenaga angin yang lebih fleksibel dan realistik, sekaligus meningkatkan kefahaman pelajar secara interaktif.

Kata kunci: alat bantu mengajar, tenaga boleh diperbaharui, turbin angin, TVET, pendidikan teknikal

I. PENGENALAN

Inovasi merujuk kepada penciptaan atau pengenalan sesuatu yang baharu atau penambahbaikan kepada kaedah sedia ada dalam menyelesaikan masalah atau meningkatkan keberkesanan sesuatu proses (Schumpeter, 1934; OECD, 2005). Dalam konteks pendidikan, inovasi dalam alat bantu mengajar adalah penting untuk mempertingkatkan pemahaman pelajar, terutamanya dalam bidang teknikal dan kejuruteraan yang menuntut penguasaan aspek teori dan praktikal secara seimbang (Mohamad, Salleh, & Othman, 2021).

Kursus DEG30013 – *Fundamental of Renewable Energy* merupakan salah satu komponen penting dalam program Diploma Kejuruteraan Elektrik (DEE) di Politeknik Sultan Haji Ahmad Shah (POLISAS), yang memberi tumpuan kepada pelbagai sumber tenaga boleh diperbaharui termasuk tenaga suria, biojisim, hidro dan tenaga angin. Seiring dengan peningkatan keperluan teknologi hijau, pemahaman mendalam mengenai konsep dan aplikasi tenaga boleh diperbaharui menjadi sangat penting (Salleh et al., 2020). Dalam kursus ini, sebanyak 25% daripada penilaian

berterusan (PB) dinilai berdasarkan pelaksanaan kerja amali yang memerlukan pelajar mengaplikasikan teori dalam situasi sebenar. Bukan sahaja boleh digunakan untuk melaksanakan amali, malah boleh digunakan didalam kelas teori dalam meningkatkan kefahaman pelajar.

Penggunaan alat bantu mengajar seperti trainer dapat membantu pelajar memahami aplikasi sebenar sistem tenaga boleh diperbaharui, khususnya dalam topik Principle of Wind Energy (Zulkifli et al., 2019). Namun, penggunaan Wind Turbine Trainer sedia ada sebelum ini hanya memfokuskan kepada pengukuran asas seperti voltan dan halaju angin menggunakan anemometer. Kekurangan dari segi visualisasi lengkap proses penjanaan tenaga dan aplikasi praktikal yang lebih interaktif menyukarkan pelajar untuk memahami sepenuhnya sistem penjanaan tenaga angin.

Sebagai langkah penambahbaikan, satu inovasi dikenali sebagai Advance Wind Turbine Trainer 2.0 telah dibangunkan. Trainer ini direka bentuk untuk memberi gambaran yang lebih komprehensif terhadap proses penjanaan tenaga angin, termasuk penukaran tenaga kinetik kepada elektrik, penyimpanan dan penggunaan tenaga tersebut

secara visual dan secara langsung. Penggunaan trainer ini dijangka dapat meningkatkan keberkesanan pengajaran dan pembelajaran serta membantu pelajar mencapai tahap penguasaan yang lebih tinggi dalam kursus berkenaan (Rahman & Ismail, 2022).

Pembangunan alat inovasi seperti ini amat penting bagi memastikan pembelajaran berasaskan kemahiran (TVET) dapat dilaksanakan secara berkesan di institusi politeknik. Ia bukan sahaja menyokong pengajaran yang lebih interaktif dan berasaskan pengalaman, malah dapat memperkukuh keupayaan pelajar dalam menyelesaikan masalah sebenar secara praktikal. Sehubungan itu, objektif kajian ini adalah:

- I. Menghasilkan Advance Wind Turbine Trainer 2.0 sebagai alat bantu mengajar bagi kursus DEG30013 – Fundamental of Renewable Energy.
- II. Menambah baik Wind Turbine Trainer terdahulu kepada versi yang lebih komprehensif dan praktikal melalui pembangunan Advance Wind Turbine Trainer 2.0.

II. KAJIAN LITERATUR

Inovasi dalam pengajaran dan pembelajaran (PdP) memainkan peranan penting dalam meningkatkan keberkesanan penyampaian ilmu, khususnya dalam bidang teknikal seperti tenaga boleh diperbaharui (Mohamad et al., 2021). Kajian oleh Mohd Nawi et al. (2020) menunjukkan bahawa penggunaan alat bantu mengajar berbentuk fizikal dan interaktif seperti trainer mampu meningkatkan motivasi pelajar serta memperkukuh pemahaman terhadap konsep kompleks melalui pendekatan pembelajaran berasaskan pengalaman (experiential learning).

Menurut Aziz et al. (2018), penggunaan renewable energy trainer dalam PdP memberi kesan positif terhadap penguasaan pelajar dalam mengaplikasikan teori ke dunia sebenar, terutamanya dalam aspek kecekapan sistem, penukaran tenaga, serta keselamatan sistem tenaga boleh diperbaharui. Pelajar juga menunjukkan peningkatan minat dan penglibatan aktif semasa sesi makmal apabila diberikan peluang untuk meneroka sistem sebenar secara langsung.

Namun begitu, Wind Turbine Trainer yang digunakan pada masa ini mempunyai beberapa kekurangan. Antaranya termasuklah skala sistem yang terhad, penggunaan beban yang ringkas, serta kekurangan keupayaan untuk menunjukkan keseluruhan proses penjanaan tenaga secara menyeluruh dan bersepadu (Rahman & Ismail, 2022). Trainer ini juga tidak mampu mensimulasikan pelbagai variasi keadaan sebenar seperti perubahan kelajuan angin atau gabungan sistem penyimpanan dan beban, menjadikan

pembelajaran kurang menyeluruh dan sukar difahami sepenuhnya oleh pelajar.

Kajian oleh Zulkifli et al. (2019) mencadangkan penambahbaikan kepada sistem sedia ada dengan menambah elemen teknikal seperti variasi turbin (horizontal dan vertical), penggunaan sistem penyimpanan tenaga (bateri), integrasi inverter, serta pemilihan beban yang sesuai untuk menunjukkan aplikasi sebenar tenaga boleh diperbaharui.

Yusof dan Rahmat (2021) pula menekankan kepentingan pembangunan trainer yang lebih pintar dan fleksibel, terutamanya dalam konteks Pendidikan dan Latihan Teknikal dan Vokasional (TVET). Ciri-ciri seperti keupayaan menunjukkan penukaran tenaga, aliran arus dan voltan, serta hubungan antara komponen-komponen utama dalam sistem tenaga boleh diperbaharui secara praktikal dianggap kritikal untuk pengajaran yang lebih berkesan.

Secara keseluruhannya, kajian-kajian lepas menyokong keperluan pembangunan semula Wind Turbine Trainer yang lebih komprehensif. Maka, pembangunan Advance Wind Turbine Trainer 2.0 merupakan satu langkah ke hadapan untuk menambah baik reka bentuk sedia ada dengan sistem yang lebih interaktif, berskala realistik, dan mampu memberikan gambaran jelas terhadap keseluruhan proses penjanaan tenaga angin secara praktikal dalam kursus DEG30013 Fundamental of Renewable Energy.

III. METODOLOGI

Perbandingan antara *Wind Turbine Trainer* versi asal dan versi penambahbaikan, iaitu *Advance Wind Turbine Trainer 2.0*, ditunjukkan dalam Jadual 1. Penambahbaikan yang dilakukan merangkumi integrasi dua jenis turbin (*Horizontal Axis Wind Turbine* – HAWT dan *Vertical Axis Wind Turbine* – VAWT) bagi memberi peluang pelajar membandingkan prestasi kedua-dua reka bentuk. Selain itu, versi baharu ini turut dilengkapi dengan bateri sebagai penyimpan tenaga, inverter untuk menukar arus terus (DC) kepada arus ulang-alik (AC), serta penggunaan mentol sebagai beban bagi menghasilkan visualisasi penggunaan tenaga yang lebih jelas dan mudah diperhatikan.

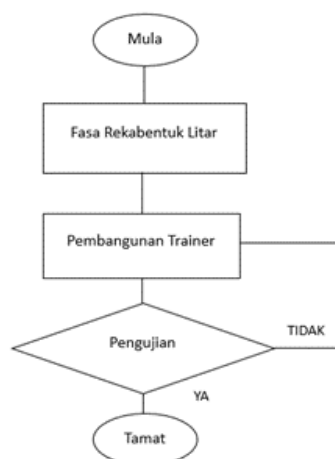
Jadual 1: Penambahbaikan Wind Turbine Trainer
vs Advance Wind Turbine Trainer 2.0

Bil	Komponen	Versi Asal (Wind Turbine Trainer)	Versi Penambahbaikan (Advance Wind Turbine Trainer 2.0)
1	Turbin	Horizontal Axis Wind Turbine (HAWT)	HAWT dan Vertical Axis Wind Turbine (VAWT)
2	Bateri	Tiada	Ada
3	Inverter	Tiada	Ada
4	Beban	LED Panel Indicator Lamp	Mentol

Metodologi pembangunan Advance Wind Turbine Trainer 2.0 dilaksanakan melalui empat fasa utama:

- Fasa 1: Reka Bentuk Litar – Mereka bentuk litar kawalan dan sambungan komponen turbin angin.
- Fasa 2: Penyediaan & Pemilihan Bahan – Menentukan spesifikasi, memilih komponen dan peralatan yang sesuai.
- Fasa 3: Pembangunan Trainer – Memasang semua komponen mengikut reka bentuk yang telah ditetapkan.
- Fasa 4: Pengujian & Penilaian – Menguji keberkesanan dan prestasi trainer, diikuti dengan penilaian hasil Pembangunan

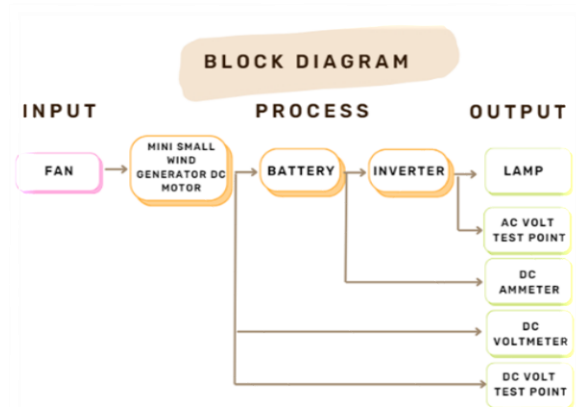
Terdapat empat fasa utama yang terlibat dalam pembangunan inovasi alat bantu mengajar (ABM) *Advance Wind Turbine Trainer 2.0*, seperti yang ditunjukkan dalam Carta Alir pada Rajah 1:



Rajah 1: Carta alir Pembangunan trainer

i) Fasa pertama: Reka Bentuk Litar

Fasa ini dimulakan melalui sesi sumbang saran dalam kalangan pensyarah, yang menghasilkan persetujuan untuk membangunkan satu alat bantu mengajar bagi topik *Principle of Wind Turbine* dalam kursus DEG30013 – *Fundamental of Renewable Energy*. Penambahbaikan turut dicadangkan bagi menggantikan trainer sedia ada supaya lebih menyeluruh dan berkesan. Rajah 2 menunjukkan gambarajah blok pembangunan inovasi. *Advance Wind Turbine Trainer 2.0* ini merupakan penambahbaikan kepada versi terdahulu yang hanya membolehkan pengukuran voltan dan halaju angin menggunakan anemometer. Walau bagaimanapun, pelajar masih tidak dapat memahami keseluruhan proses penjanaan tenaga angin secara visual dan praktikal. Dalam versi 2.0 ini, dua jenis turbin (horizontal dan vertical) digunakan. Pelajar dapat membandingkan prestasi kedua-dua turbin dan memahami konsep melalui amali sebenar. Penambahan komponen seperti bateri (DC 12V), inverter, dan beban lampu membolehkan sistem menyimpan tenaga dalam bentuk arus terus (DC) dan menukarnya kepada arus ulang alik (AC) untuk aplikasi sebenar seperti pencahayaan rumah.



Rajah 2. Gambarajah Blok Pembangunan Inovasi

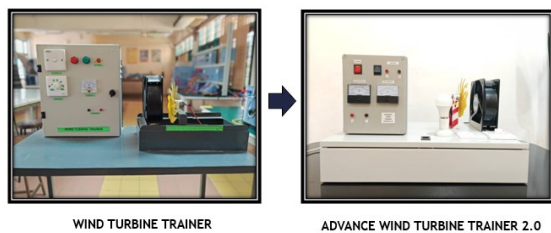
2. Fasa kedua: Penyediaan dan Pemilihan Bahan

Komponen utama yang digunakan dalam pembangunan sistem ini ialah:

- Exhaust Fan 220V–240V AC – sebagai sumber angin simulasi
- Mini Wind Generator DC Motor 12V – sebagai turbin angin
- Bateri 12V – untuk penyimpanan tenaga
- Inverter DC ke AC 12V–220V (500W) – untuk penukaran arus
- Pemilihan bahan ini dibuat berdasarkan aspek keselamatan, kesesuaian kuasa, kemudahan pemasangan dan kos.

3. Fasa ketiga Pembangunan Trainer

Proses pembinaan prototaip trainer bersaiz mini telah berjaya dilaksanakan. Dimensi trainer adalah 610 x 400 x 120 mm, bersaiz kompak dan mudah alih. Ia direka supaya *exhaust fan* (sebagai sumber angin) dan turbin dipasang dalam satu struktur yang lengkap, menjadikan pengendaliannya mudah untuk pensyarah dan pelajar. Tidak seperti trainer bersaiz besar sebelum ini yang memerlukan ruang penyimpanan luas, reka bentuk ini menjimatkan ruang dan sesuai untuk sesi pengajaran dalam kelas. Rajah 3 menunjukkan prototaip lengkap *Advance Wind Turbine Trainer 2.0* yang siap dibangunkan.



Rajah 3. Penambakan Trainer

4. Fasa Keempat: Pengujian dan Penilaian

Pengujian untuk *trainer* dilakukan bagi memastikan ianya berfungsi dan bertepatan dengan objektif yang telah disasarkan. Berdasarkan rajah 4 dibawah, menunjukkan pengoperasian Wind Turbine. Apabila Wind Turbine berpusing, tenaga elektrik akan terhasil. Apabila tenaga elektrik telah terjana, DC analog Voltmeter akan memaparkan bacaan. Wind Turbine juga akan menyimpan tenaga yang dijana didalam bateri 12V. Setelah Inverter telah dihidupkan, ia akan menukarkan nilai 12V DC kepada 220AC-240AC sesuai untuk menghidupkan beban seperti lampu.



Rajah 4: Advance Wind Turbine Trainer 2.0 berfungsi

Jadual 1: Keputusan pengujian Wind Turbine Trainer

Fan Speed Setting	Wind Speed (m/s)	Horizontal Turbine Voltage (V)	Vertical Turbine Voltage (V)	Inverter		
				DC(V)	AC(V)	Current (A)
2	2.12	3.5	0.2	12.3	231	1.2
3	4.56	9.5	0.6	12.3	231	1.2
5	6.06	13	0.8	12.3	231	1.2

Jadual 1 menunjukkan bahawa apabila kelajuan kipas meningkat daripada tahap 2 ke tahap 5, kelajuan angin turut meningkat daripada 2.12 m/s kepada 6.06 m/s. Peningkatan kelajuan angin ini menghasilkan kenaikan voltan pada Horizontal Turbine dari 3.5 V ke 13 V, manakala voltan bagi Vertical Turbine juga bertambah sedikit dari 0.2 V ke 0.8 V. Voltan DC inverter kekal stabil pada 12.3 V, manakala output AC juga kekal pada 231 V dengan arus 1.2 A.

Secara keseluruhan, keputusan ini selari dengan teori, iaitu semakin tinggi kelajuan angin, semakin tinggi tenaga kinetik yang diubah menjadi tenaga elektrik — terbukti Horizontal Turbine lebih efisien pada kelajuan angin tinggi berbanding turbin menegak.

Kelebihan:

1. Sesuai dengan teori tenaga angin, menunjukkan peningkatan output apabila kelajuan angin meningkat.
2. Horizontal Vertical terbukti lebih berkesan menjana tenaga berbanding turbin menegak dalam keadaan ujian ini.
3. Inverter berfungsi baik, memastikan output AC stabil walaupun voltan input berubah.
4. Latihan praktikal membuktikan konsep teori dapat diaplikasikan dalam keadaan sebenar, membantu pelajar memahami hubungan antara reka bentuk turbin, kelajuan angin, dan hasil penjanaan kuasa.

IV. KESIMPULAN

Advanced Wind Turbine Trainer 2.0 memberikan peluang kepada pelajar untuk melibatkan diri secara langsung dalam pengalaman praktikal serta mengaplikasikan pengetahuan teori yang telah dipelajari. Melalui penggunaan trainer ini, pelajar dapat memahami keseluruhan proses penjanaan tenaga angin dengan lebih jelas, di samping menilai perbezaan prestasi antara dua jenis turbin angin iaitu *Horizontal Axis Wind Turbine* dan *Vertical Axis Wind Turbine*.

Inovasi *Advanced Wind Turbine Trainer 2.0* ini juga dibangunkan dengan kos yang rendah serta berpotensi dihasilkan dalam jumlah yang banyak, sekali gus memberi peluang kepada lebih ramai pelajar untuk menggunakannya dalam kumpulan yang lebih besar. Pada masa yang sama, pengajar dapat menilai tahap pemahaman pelajar melalui ujian praktikal serta memastikan pelajar benar-benar menguasai topik yang diajar.

PENGAKUAN

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Exploring Student Perspectives on The Effectiveness of Using E-Book: Easy Notes for Project Management and Practices

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Abstract

This study aims to explore students' perceptions of using E-Book Easy Notes for Project Management and Practices among students taking the Project Management and Practices Course at Polytechnic Sultan Mizan Zainal Abidin. In an era where digital learning tools are increasingly pivotal in education, e-Books offer simplified, accessible, and innovative methods to navigate complex subjects. The objective of this research is to evaluate students' perceptions of the usability and effectiveness of e-Book Easy Notes in learning Project Management and Practices. This study uses a quantitative method through a questionnaire distributed to 62 students in the Civil Engineering Department who take this course. The data is analyzed using statistical software (SPSS) version 27.0 to identify the respondent perception, learning experience using E-Book, level of effectiveness of E-Book and respondents' perception using this E-Book as a supplementary learning resource. The findings of the study shows that the respondent's perception of this E-Book was rated very positively, with the average mean score of 4.71 and 0.58 standard deviation. While in terms of learning experience aspect, this E-Book was also rated with an average mean score of 4.73 and a standard deviation of 0.51. The effectiveness of this E-Book is also rated as very good with an average score of 4.78. For the respondent's satisfaction using this E-Book, the average mean score obtain is 4.75 and 0.51 standard deviation. Based on the findings obtained, it shows that this E-Book is a very effective and useful learning tool for students. It also has the potential to continue to be widely used in improving the learning experience among students.

Keywords : *Students Perspective, Effectiveness, E-Book Easy Notes for Project Management and Practices*

I. INTRODUCTION

In the modern educational landscape, digital resources have become instrumental in shaping student learning experiences and outcomes. Among these, e-Books have emerged as a prominent tool, offering convenience, accessibility, and an innovative approach to acquiring knowledge. This research focuses on the implementation and impact of one such resource e-Book Easy Notes within the context of Project Management and Practices. Project management, as a critical discipline, requires a comprehensive understanding of theories, strategies, and practical applications. Traditional learning methods, while effective, often fall short in catering to diverse student needs in today's fast-paced, tech-driven world.

E-Book Easy Notes is designed as a user-friendly digital companion that simplifies complex concepts and supports self-paced learning. However, the

effectiveness of such tools is contingent upon how students perceive and interact with them. Understanding their perspective is crucial for evaluating the utility and areas of improvement of these resources. This study seeks to explore students' attitudes, experiences, and feedback regarding the use of e-Book Easy Notes in mastering Project Management concepts. By delving into their perspectives, this research aims to shed light on the strengths and limitations of e-Books in bridging the gap between theoretical knowledge and practical application.

The findings of this research are anticipated to provide educators with valuable insights into the integration of e-Books into academic curricula, thereby fostering more effective and engaging learning environments. Ultimately, this study underscores the importance of aligning educational tools with the evolving needs and preferences of

students to promote optimal learning outcomes in the field of Project Management.

II. PROBLEM STATEMENT

The increasing reliance on digital educational resources has highlighted the need for effective tools that enhance learning experiences. While e-Books such as Easy Notes for Project Management and Practices have gained popularity for their ability to simplify complex subjects, their impact on students' understanding and application of Project Management principles remains unclear. Despite their potential, there is limited research on how students perceive the usability, effectiveness, and overall contribution of e-Book Easy Notes to their learning process. This gap in understanding poses challenges for educators seeking to optimize digital learning tools and tailor them to student needs. Addressing this issue is crucial for improving educational practices and ensuring that digital resources like e-Books fulfil their promise of promoting student success in dynamic and demanding fields like Project Management.

III. LITERATURE REVIEW

The integration of digital tools in education has revolutionized the way students' access and engage with learning materials. E-Books have emerged as a significant resource, offering portability, interactivity, and accessibility. According to research, e-Books provide students with the flexibility to learn at their own pace, making them an effective tool for self-directed learning [1]. Despite the growing availability and perceived advantages of e-books, many students continue to favor traditional print books for academic reading. A study involving students from the University of Agder found that while students expressed positive attitudes toward e-readers, a majority preferred print for serious academic study [1].

However, the effectiveness of e-Books depends significantly on their design and usability. Research indicates that poorly designed digital resources can lead to cognitive overload, reducing their educational value. Therefore, understanding students' perspectives on the usability and effectiveness of e-Books is crucial for optimizing their design and functionality [3]. E-Book Easy Notes, as a specific digital tool, aims to address these challenges by providing concise and user-friendly content tailored to the needs of project management students. While there is limited research specifically on e-Book Easy Notes, studies on similar tools

suggest that students value features such as searchability, annotation capabilities, and real-world examples [2].

E-Book Easy Notes, as a specific digital tool, aims to address these challenges by providing concise and user-friendly content tailored to the needs of project management students. While there is limited research specifically on E-Book Easy Notes, studies on similar tools suggest that students value features such as searchability, annotation capabilities, and real-world examples [4]. These features not only enhance engagement but also improve knowledge retention and application.

Despite the advantages, challenges remain in the adoption of e-Books. Factors such as digital literacy, access to technology, and individual learning preferences play a significant role in determining their effectiveness. Addressing these challenges requires a comprehensive understanding of students' experiences and feedback, which this research aims to provide [3].

E-books are often praised for their portability and convenience, allowing students to access learning materials anytime and anywhere. Studies highlight that students appreciate the ability to search for keywords, annotate, and bookmark within e-books, which enhances their learning experience. For instance, [5] emphasize that e-books provide students with efficient and accessible reading tools, making them favourable in modern educational settings. Additionally, [6] found that university students viewed e-books as effective learning resources, especially during the pandemic when accessibility and portability became crucial for academic success.

The integration of multimedia elements, such as videos, quizzes, and hyperlinks, in e-books has been shown to improve engagement and comprehension. Interactive e-books are noted for their effectiveness in catering to diverse learning styles and improving academic outcomes. For example, [7] demonstrated that interactive e-books significantly enhance students' academic performance, engagement, and satisfaction by incorporating multimedia elements such as videos and quizzes [7].

Interactive and well-structured e-books are more likely to yield positive results compared to static digital texts. For instance, [8] demonstrated that e-books with interactive features and well-organized content significantly improve student engagement and academic performance. Students with limited access to reliable internet connections or appropriate digital devices often struggle to engage with digital learning materials effectively. These challenges are especially pronounced in rural or low-income

communities, where students may depend on outdated hardware or shared devices. Additionally, a lack of institutional support, such as training or access to academic platforms, can further hinder students' ability to utilize e-books to their full potential. According to [9], students from marginalized backgrounds in Malaysia reported significant barriers to online learning due to digital inequity, which also affected their interaction with e-books and other digital resources.

Similarly, [10] found that during the COVID-19 pandemic, the digital divide significantly impacted students' educational experiences, reinforcing existing inequalities and highlighting the need for more inclusive digital infrastructure. These findings emphasize that while e-books offer many advantages, their benefits are not universally accessible without addressing underlying socio-technical disparities. [11] emphasized the role of digital technologies, including e-books, in improving accessibility and personalizing learning experiences in modern education systems.

However, student responses to e-books are not universally positive. Some research highlights challenges and limitations associated with e-book usage. For example, [12] noted that while some students preferred the digital format, others still favoured printed books due to eye strain, navigation difficulties, and the tactile experience offered by physical texts. This divide often correlates with students' technological proficiency, learning preferences, and the subject matter of the course.

The effectiveness of e-books also varies depending on the discipline and type of content. Studies have shown that for subjects requiring intensive reading or referencing, such as law or medicine, students often prefer physical books due to their ease of navigation and reduced eye strain [13]. The use of e-books in educational settings has gained considerable momentum, particularly with the rise of digital learning platforms. Many students appreciate e-books for their convenience, portability, and cost-effectiveness. E-books enable instant access to a wide range of academic resources and support interactive features such as highlighting, note-taking, and multimedia integration. These functionalities are often cited as key reasons for students' growing interest in digital texts [9][14]. E-books are widely recognized for their portability, cost-effectiveness, and accessibility, making them a popular choice among students [8][15]. However, students' perspectives on e-books vary widely, influenced by factors such as individual learning styles, technological proficiency, and the nature of the academic content [5].

IV. RESEARCH METHODOLOGY

A. Research Design

This study used a descriptive quantitative approach, utilizing a questionnaire as the primary tool for data collection. The questionnaire was distributed to respondents through Google Forms to ensure accessibility and convenience. It is divided into five key sections: Respondent Demographic, User Perception of E-Book Interface, Learning Experience, Effectiveness of E-Book and Student's Satisfaction of Using E-Book.

B. Research Sample

The sample for this study consists of 62 Civil Engineering students taking the DCC40132: Project Management and Practices course.

C. Data Analysis

The study items were measured using scores based on the Likert Scale. Data was analysed using Statistical Package for Social Science (SPSS) version 27.0 to obtain the value of mean score and standard deviation. This mean and standard deviation translated into the Student Perspectives on The Effectiveness of Using E-Book: Easy Notes for Project Management and Practices.

Table 1: Score Mean Interpretation

Score Mean	Interpretation
1.00 – 2.33	Low
2.34 – 3.66	Moderate
3.67 – 5.00	High

V. RESEARCH FINDINGS AND DISCUSSION

A. Respondent Demography

Table 2 : Respondent Demography

		Frekuensi (f)	Peratus (%)
Gender	Male	34	55.0
	Female	28	45.0

B. Effectiveness of Using E-Book: Easy Notes for Project Management and Practices

Table 3 : User Perception of E-Book Interface

Bil	Item	Mean	Sd
1	The interface of E-Book Easy Notes is easy to navigate	4.74	0.57
2	I find the content of E-Book Easy Notes to be well-organized	4.70	0.58

3	E-Book Easy Notes is accessible on the devices frequently	4.70	0.58
Average		4.71	0.58

Table 3 above shows the result of the user perception of E-Book Easy Notes for Project Management and Practices interface. Based on the results of the study, the first item, which assessed the ease of navigation of the E-Book Easy Notes showed a mean of 4.74 with a standard deviation of 0.57. This indicates that most respondents found the application interface to be very easy to navigate, with relatively small variations in their responses as demonstrated by the low standard deviation.

The second item also assessed the respondents' perception of the organization of the E-Book content. With a mean of 4.70 and a standard deviation of 0.58, this data shows that most respondents felt that the content in the E-Book was organized and easy to follow, with a relatively low variation in responses.

For the third item, which measures the accessibility of the E-Book, the mean of 4.70 and standard deviation of 0.58 indicate that the application has a high level of accessibility. The nearly identical standard deviations suggest a high level of agreement in respondents' responses.

Overall, the mean of 4.71 with a standard deviation of 0.58 indicates that the E-Book is highly rated by users in terms of user-friendliness, content organization, and cross-device accessibility. High scores for all three elements indicate that the E-Book is very user-friendly and meets the needs of most students for a simple and effective learning experience.

Table 4 : Learning Experience

Bil	Item	Mean	Sd
1	E-Book Easy Notes enhances my understanding of Project Management and Practices.	4.75	0.46
2	Using E-Book Easy Notes makes learning more engaging	4.70	0.55
3	Feel confident in applying the knowledge gained through E-Book Easy Notes	4.74	0.51
Average		4.73	0.51

Table 4 above shows the item of student's learning experience using E-Book Easy Notes for Project Management and Practices. For the first item assessing the effectiveness of the E-Book in improving the understanding of Project Management and Practices, the mean value is 4.75 with 0.46 standard deviation which indicates that

most respondents felt that E-Book was very helpful in improving their understanding. The small standard deviation value indicates that almost all respondents had similar views, with little variation in ratings. For the second item, which examined the extent to which the E-Book makes learning more engaging, the mean of 4.70 and standard deviation of 0.55 indicates that the majority of respondent found the E-Book more engaging. The slightly higher standard deviation compared to the first points indicates differences in user responses, but overall, the positive impact on the learning experience was clear.

Regarding the third item, which measures users' confidence in applying the knowledge gained in the E-Book, the mean of 4.74 and standard deviation of 0.51 indicate that most users feel very confident in the practical application of the knowledge gained in this E-Book. This indicates that this E-Book not only facilitates understanding but also provides confidence in the practical application of knowledge.

The overall mean of 4.73 with a standard deviation of 0.51 indicates that the E-Book is highly appreciated by users for project management and interactive learning. The majority of respondents felt that the e-book not only improved their understanding but also made learning more interesting and gave them the confidence to apply the knowledge gained.

Table 5 : Effectiveness of E-Book Easy Notes for Project Management and Practices.

Bil	Item	Mean	Sd
1	E-Book Easy Notes provides relevant and up-to-date information on Project Management	4.80	0.43
2	The visual aids (e.g., diagrams) in E-Book Easy Notes are helpful for understanding complex topics	4.75	0.46
3	E-Book Easy Notes is an effective tool for preparing assignments and exams	4.79	0.48
Average		4.78	0.46

The above Table 5 shows the mean and standard deviation result for the effectiveness of E-Book Easy Notes for Project Management and Practices. The first item shows that the E-Book scores highly in providing up -to date information related to project management where the value of mean is 4.80 and standard deviation is 0.43. This reflects the student's confidence that the content is updated and aligned with current curriculum requirements. For the second item, the mean value obtained is 4.75 with

0.46 standard deviation for the effectiveness of visual aids such as diagrams in aiding the understanding of complex topics. The third item shows that students consider the E-Book to be an effective tool for preparing assignment and exams, with a mean of 4.79 and a standard deviation of 0.48. This indicates that the E-Book content is presented in a practical manner and easy to use as a primary reference.

The overall mean of 4.78 with a standard deviation of 0.46 indicates that the E-Book not only provides relevant and high-quality information but is also presented visually and practically to promote student understanding. The consistent ratings indicate a positive consensus among students regarding the functionality and effectiveness of the e-book in an academic context.

Table 6 : Student's Satisfaction Using E-Book Easy Notes for Project Management and Practices.

Bil	Item	Mean	Sd
1	Satisfied with the overall quality of E-Book Easy Notes	4.72	0.54
2	Would recommend E-Book Easy Notes to other students	4.74	0.54
3	Overall experience using E-Book Easy Notes has been positive	4.79	0.44
Average		4.75	0.51

Table 6 above shows that the student's satisfaction using E-Book Easy Notes for Project Management and Practices. For the first item, score mean value obtained is 4.72 with a standard deviation of 0.54, indicated a high level of satisfaction with the overall quality of E-Book. Although there was some variation in responses, most respondents rated the quality of E-Book positively. The second item indicated that students are willing to recommend this E-Book to their friends, with a mean of 4.74 and a standard deviation of 0.54. This indicates a high level of trust in the E-Book as a useful and reliable learning resource. The third item show the highest mean value of 4.79, with a standard deviation of 0.44, illustrating that the overall experience of students using the E-Book was very positive. The low standard deviation value also indicates uniformity in users' perceptions of their experience.

Overall, the mean of 4.75 with a standard deviation of 0.51 indicates that students rated the E-Book very positively in terms of quality, reliability and user friendliness. The high mean score across all items indicates high satisfaction, while the moderate variability in responses, which a stable range for positive interpretations.

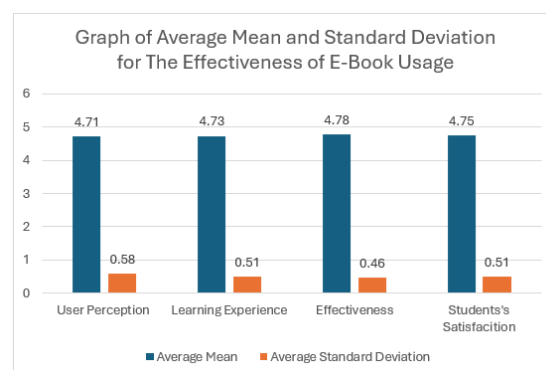


Figure 1: Graph of Average Mean and Standard Deviation for The Effectiveness of E-Book Usage

Figure 1 above show the graph of average mean and standard deviation for the effectiveness of E-Book usage. For the first item evaluated, the average mean obtained is 4.71 with a standard deviation of 0.58 indicates that the E-Book is highly rated by users in terms of user-friendliness, content organization, and cross-device accessibility. For the learning experience, can be seen that the average mean obtained is 4.73 with a standard deviation of 0.51 indicates that the E-Book is highly appreciated by users for project management and interactive learning. Most respondents felt that the e-book not only improved their understanding but also made learning more interesting and gave them the confidence to apply the knowledge gained. While the average mean for effectiveness item is 4.78 with a standard deviation of 0.46 indicates that the E-Book not only provides relevant and high-quality information but is also presented visually and practically to promote student understanding. For student's satisfaction also, it shows that the average mean obtained is 4.75 with a standard deviation of 0.51 indicates that students rated the E-Book very positively in terms of quality, reliability and user friendliness.

VI. CONCLUSION

In conclusion, the students' perspectives in using E-Book Easy Notes for Project Management and Practices were overwhelmingly positive across all assessed dimensions. As education continues to embrace digital transformation, e-books have emerged as pivotal tools for enhancing accessibility, engagement, and learning outcomes. The results of this study affirm that *E-Book Easy Notes* is an effective and well-received learning resource, appreciated for its usability, content organization, accessibility, and overall user experience. This e-book not only provides relevant and up-to-date information, but is also easy to use, and very helpful in learning. With high accessibility and good content layout, the E-Book Easy Notes successfully provides a platform that supports interactive learning and makes it easier for students to prepare

for assignments and final exams. Compared to traditional learning methods, this e-book offers distinct advantages such as portability, interactive features, and immediate access to updated content. These benefits not only support self-paced learning but also reduce dependency on physical materials, making it especially valuable in remote or hybrid learning environments.

Moreover, the insights gained from this study can inform future e-book design by emphasizing user-centered features such as intuitive navigation, modular content structure, and embedded multimedia elements. Designers and educators should consider these factors to optimize digital learning tools for diverse student populations. However, future research should aim to broaden the scope of analysis. Expanding the sample size, including participants from multiple institutions, and incorporating qualitative data such as interviews or focus groups would provide richer insights into user experiences and learning outcomes. Longitudinal studies could also explore the sustained impact of e-book usage on academic achievement and digital literacy. Overall, *E-Book Easy Notes* demonstrates strong potential as a scalable and impactful educational tool, with implications for both pedagogical practice and digital resource development.

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Exploring The Impacts of Visual Aids On English Language Learning At Politeknik Tuanku Sultanah Bahiyah, Kulim

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Abstract

English proficiency is a critical component of academic success and professional development within Malaysia's polytechnic, where both functions as a compulsory subject and as a medium of instruction. However, students frequently encounter challenges acquiring the language. This study examines the impact of visual aids on English language learning among semester 5 students at Politeknik Tuanku Sultanah Bahiyah, Kulim (PTSB). It investigates the impacts of visual aids such as pictures, online tools, videos, and PowerPoint slides in improving comprehension, motivation and engagement. The research was conducted using a structured questionnaire adapted from validated instruments and administered to 53 respondents. The data has been analysed using SPSS. The findings demonstrate that integrating visual aids significantly improve English learning by making lessons more engaging and improving students' understanding and motivation. Recommendations are provided for incorporating visual aids into English language teaching.

Keywords : *Pedagogical tools; TVET; Visual aids*

I. INTRODUCTION

In Malaysia's polytechnic system, English is a core subject that supports academic development and employability. Among the English courses offered are Communicative English and Technical English. Students are required to take at least two English papers during their studies, depending on their programme structure.

English is the language of business and industry. Most job interviews, emails, reports, and presentations are conducted in English. Students are required to communicate effectively to thrive in the workplace, especially in multinational companies. During internships or interviews, students are often expected to speak confidently and write clearly in English. English is the medium of instruction for many technical subjects. If students have poor English, they may struggle to understand lecture notes, exam questions, or reference materials.

Many textbooks, research papers, and technical manuals are in English, thus strong reading and writing skills help students learn better.

English competency is not only essential for academic success but also for communication in the workforce. Despite being a compulsory subject, many students face difficulties in learning English due to limited vocabulary, poor comprehension skills, and low motivation. Many students have low

to intermediate English proficiency when they first enrol at polytechnics. As a result, educators must find effective strategies to improve learning outcomes.

Visual aids such as images, videos, charts, and real objects have been widely recognized for their potential to make learning more engaging and accessible. In polytechnic settings, where students are practically oriented, the use of visual and multimedia content can align learning with real-world applications. According to Shabiralyani et al. [1] visual aids are important in education system. Visual aids are those devices which are used in classrooms to encourage students learning process and make it easier and interesting. They are those sensory objects or images which initiate or stimulate and support learning. For example, visual aids such as animation videos, pictures, maps, charts and models as motivation tools increase interest on reading literary text, which in turn smoothens the learning to students. In addition, visual aids can be defined as tools that use visual elements, such as images, charts, graphs, and videos, to enhance understanding and retention of information. Visual aids can significantly improve comprehension for English language learners by providing visual context and support to verbal communication. [2].

II. LITERATURE REVIEW

This study is guided by Cognitive Load Theory (CLT), developed by John Sweller [3]. It is a theory about how people learn based on how much information their working memory can handle at one time. It provides a framework for understanding how visual aids can be used effectively in English classrooms at the polytechnic level and help educators design instructional materials that are easy to understand and don't overload the learner's mind. So, teachers were encouraged to avoid to overloading students with words alone while teaching but might use pictures and words to elaborate difficult concepts. By reducing unnecessary cognitive burden and supporting meaningful processing, well-designed visual aids can enhance students' comprehension, retention, and application of English language skills.

Several studies have highlighted the advantages of integrating visual aids in classroom learning. As reported by Shabiralyani et al. [1], using visual aids as a teaching method stimulates thinking and improves personal understanding of the areas of learning when they experience a successful and pleasant learning in the classroom. Students consider visual aids helpful and relevant when they clearly relate to what they are learning in the course content.

Similarly, Hamad [4] concluded that one can draw the conclusion that employing visual aids in the classroom as a kind of pedagogical support helps to improve the atmosphere of learning there. Learning settings that are too monotonous can be replaced with effective use of visual aids. When students have positive and enjoyable learning experiences in the classroom, it deepens their understanding of the content and broadens their overall knowledge.

Other studies have emphasized the link between visual aids and active participation. Dalali and Mwila [5] found out that the use of visual aids in teaching and learning process is said to lead to active participation of students in the teaching and learning process which in turn influences their academic achievement. Visual aids used in teaching and learning should possess the essential qualities of effective instructional tools, such as adequate size for visibility, clear readability, and relevance to the topic being presented. These findings are consistent with observations from Noha [6] where students who were initially hesitant to participate gradually gained self-confidence and became more interactive when visual aids were incorporated. Visual aids acted as 'understanding and participation boosters' enabling learners to engage more actively in reading, speaking and classroom discussions.

Abd Karim and Mustapha [7] conducted a study on digital mind map to stimulate learning of technical skills, as it is becoming increasingly popular in today's pedagogical visual aids among TVET students. The respondents mostly agreed that the digital mind map allowed them to learn easier and faster in their studies. Likewise, Lim and Tan Chia et al. [8] reported that the role of infographics in EFL students' multimodal literacy and reading comprehension. Their study revealed that the use of infographics significantly improved learners' comprehension of texts, as the combination of visuals and textual information made complex ideas more accessible. It indicates that visual aids not only enhance students' ability to process and retain information but also promote deeper engagement in English language learning. When these two studies were compared, collectively, these findings reinforce the view that visual aids not only facilitate learning but also promote deeper engagement and understanding across diverse educational contexts. Several studies have demonstrated that visual aids do more than just facilitate comprehension, they also significantly enhance students' motivation. For example, As Sabiq's [9] classroom action research rising from 57% to 90% of students expressing high motivation when audio-visual media were used in English reading classes. Similarly, a study conducted at MSU [10] revealed that multimedia tools not only captured attention but inspired students to engage more creatively with English learning tasks.

III. OBJECTIVE OF THE STUDY

1. To identify the types of visual aids commonly used in English language classes in polytechnics.
2. To evaluate the impact of visual aids on students' comprehension, motivation, participation and overall achievements in English classroom.

IV. RESEARCH QUESTIONS

1. What types of visual aids are used in polytechnic English classrooms?
2. How do visual aids influence students' understanding, motivation and participation in English class?

V. RESEARCH METHODOLOGY

A) Research design

This study used a quantitative research in which structured questionnaires were distributed to selected respondents.

B) Population and sample

Conducted at Politeknik Tuanku Sultanah Bahiyah (PTSB). The target population consisted of Semester 5 students who had undertaken three English courses

during their studies at the polytechnic. This group was selected because they were considered to have sufficient exposure to the English language and were therefore able to provide informed responses regarding the use of visual aids in their learning experiences, making them suitable respondents for the study.

C) Data collection instrument

The instruments that the researcher uses are structured questionnaire (Likert-scale), ranging from Strongly Disagree (1) to Strongly Agree (5), was employed for perception and impact related items. The researcher has adopted different types of questions which are from Singh et al. [11] and Dalali and Mwila [6]. Moreover, the questionnaires that are adapted are from a valid and reliable source. To ensure content validity, the adapted questionnaire was reviewed by two subject-matter experts in English language teaching.

VI. RESULT AND DISCUSSION

The quantitative findings of this research that have been gathered from the responses were analysed by using the Statistical Package for Social Science (SPSS) application.

Section A: Demographic Information

In total, there were 53 respondents with 73.6 percent are male and 26.4% are female.

Section B: Frequency and types of Visual Aids

Table 1

ITEM	MEAN	SD
2. How often does your English lecturer use visual aids in class?	4.7	0.55

Table 1 shows the frequency and types of visual aids. The descriptive analysis produced a mean score of 4.70 (SD = 0.55), indicating that respondents generally perceived their English lecturers as frequently and consistently integrating visual aids into classroom teaching.

Table 2

ITEM		
3. What types of visual aids are most commonly used in your English class? (You may choose more than one option)		
VISUAL AIDS	MEAN	SD
Pictures or Flashcards	0.68	0.47
PowerPoint Slides	0.98	0.14
Videos/Films(e.g. YouTube)	0.59	0.50
Charts/Graphs/Infographics /Posters	0.53	0.50

Real objects (e.g : Phamplets/Brochures/Toys)	0.43	0.50
Online tools (e.g., Kahoot, Quizzes)	0.94	0.24
Whiteboard drawings	1.00	0.00
Mind Maps	0.45	0.50

Table 2 shows the types of visual aids used in English class. The descriptive analysis of the multiple-response data revealed that whiteboard drawings (M = 1.00, SD = 0.00), PowerPoint slides (M = 0.98, SD = 0.14), and online tools (M = 0.94, SD = 0.24) were the most consistently used visual aids in English classes, as reflected by their high means scores and minimal variability in respondent responses.

Other visual aids such as pictures or flashcards (M = 0.68, SD = 0.47), videos (M = 0.59, SD = 0.50), and charts/graphs/posters/infographics (M = 0.53, SD = 0.50) indicated moderate use, but with greater variability, suggesting differences among lecturers' practices. Meanwhile, mind maps (M = 0.45, SD = 0.50) and realia (M = 0.43, SD = 0.50) recorded lower mean values, showing that these aids were less frequently adopted.

Overall, the findings suggest that although traditional tools like whiteboard drawings and PowerPoint slides continue to dominate, the integration of online tools is also highly prevalent, whereas other aids are used inconsistently across classes.

Section C: Student Perception on Visual Aids

Table 3

ITEM	MEAN	SD
4. I believe that lecturers should always prepare visual aids for their teaching and learning process.	4.75	0.43
5. I consider that visual aids will lead to my active participation in class	4.53	0.54
6. I believe that visual aids can help me to understand the lesson easily.	4.47	0.60
7. I believe that the classroom should be covered with different kinds of visual aids.	4.66	0.47
8. I believe using visual aids frequently can improve my academic performance.	4.38	0.59
9. I believe when my lecturer involves visual aids in the learning process, I can finish all the tasks easily.	4.28	0.63

10. I believe visual aids make me more motivated in class.	4.36	0.59
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Table 3 shows the respondents perception on visual aids.

For item number 4, the results indicated a mean score of 4.75 (SD = 0.43), demonstrating strong respondents support for the use of visual aids in the teaching and learning process, with very little variation in their responses.

For item number 5, the findings revealed a mean score of 4.53 (SD = 0.54), indicating that respondents generally agreed that visual aids enhance active participation with relatively low variability in responses. Agwu, and Ogochi [12] had also reported that motivation in learning process, is enhanced when using visual aids besides active participation during lesson presentations.

For item number 6, the result showed a mean of 4.47 (SD = 0.60), indicating that respondents generally agreed that visual aids enhance their comprehension of lessons. This aligns with Singh et al. [11] who found that visual tools can be significantly support the learning process by making lesson content easier for respondents to comprehend.

For item number 7, the analysis produced a mean of 4.66 (SD = 0.47), indicating a strong level of agreement among respondents. This suggests that respondents place significant on having variety of visual aids in their learning environment.

For item number 8, the analysis showed a mean score of 4.38 (SD = 0.59), suggesting that respondents generally agreed that visual aids positively contribute to their academic achievement, with relatively low variability in responses.

For item number 9, the descriptive statistics indicated a mean of 4.28 (SD = 0.63), reflecting overall agreement among respondents. This implies that respondents generally recognize the effectiveness of visual aids in helping them accomplish classroom tasks efficiently.

For item number 10, the descriptive statistics revealed a mean score of 4.36 (SD = 0.59), indicating that respondents generally agreed that visual aids boost their motivation in the classroom. The finding indicate that students hold very positive perceptions of visual aids in teaching and learning.

All items scored above 4.28 on a 5-point scale, indicating strong agreement overall.

The highest agreement was that lecturers should always prepare visual aids (M = 4.75, SD = 0.44).

The lowest agreement, though still positive, was the belief that visual aids help them complete tasks easily (M = 4.28, SD = 0.63).

Standard deviations were all below 0.65, suggesting low variability and relatively consistent responses.

This indicates that respondents view visual aids as essential tools for understanding lessons, encouraging participation, boosting motivation, and supporting their overall academic performance.

Section D: Overall Impact

Table 4

ITEM	MEAN	SD
11. In your opinion, how important are visual aids in English language learning?	4.62	0.48

Table 4 shows the importance of visual aids.

For item 11, the descriptive statistics revealed a mean score of 4.62 (SD = 0.48), reflecting strong agreement on the importance of visual aids. This shows that respondents almost unanimously recognize visual aids as an essential element of effective English learning.

Table 5

12. Would you like your lecturer to use more visual aids in the future?		
RESPONSES	FREQUENCY	PERCENT
YES	53	100
NO	0	0

Table 5 shows the frequency distribution of responses. For item 12, all 53 respondents (100%) indicated that they would like lecturers to incorporate more visual aids in future lesson. It confirms that respondents unanimously support the expanded use of visual aids in English language teaching.

Despite these findings, this study has certain limitations. The research was conducted in only one polytechnic, which limit the generalizability of the result to another context. Students' perceptions and lecturers' practices in different institutions may vary due to difference in teaching styles or resources. To address this limitation, future research should be conducted across multiple polytechnics and involve the scope in this way would strengthen the validity of the finding and offer broader insights for improving teaching practices across the polytechnic system.

VII. CONCLUSION

Visual aids are highly effective in enhancing English learning in polytechnic. The findings demonstrate that visual aids are highly valued by students, which also significantly improve comprehension, motivation, participation and overall academic achievement. It is consistent with Andayani [13] who found that visual media can effectively enhancing cognition in students, particularly in the context of English education.

Students consistently reported that lecturers' use of visual aids, including whiteboard drawings, PowerPoint presentation, and online tools, makes lessons more engaging and easier to understand. Traditional aids like pictures, videos, and charts were also beneficial, although their usage was less consistent. The highest agreement among students was on the importance of lecturers preparing visual aids for teaching, while the lowest, though still positive, related to their role in helping students' complete tasks efficiently.

Additionally, descriptive statistics further indicate that visual aids not only facilitate understanding but also stimulate active participation, boost motivation, and contribute positively to academic achievement. Students strongly agreed on the necessity of incorporating a variety of visual aids in classrooms, reflecting a clear preference for interactive and visually rich learning environments. Importantly, all respondents expressed unanimous support for increased use of visual aids in future lessons.

The study confirms that visual aids are essential pedagogical tools in polytechnic English classroom. Their strategic and consistent integration into teaching can significantly improve learning outcome, engagement and motivation. Lecturers are therefore encouraged to continue using diversifying visual aids to create more effective and stimulating learning experiences in English language instruction.

VIII. RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed for enhancing the use of visual aids in English language teaching at polytechnics. Firstly, lecturers should consistently prepare and integrate a variety of visual aids, such as PowerPoint slides, whiteboard drawings, videos, charts, and online interactive tools, to support lesson delivery and maintain student engagement. To accommodate different learning styles, lecturers should use a combination of traditional tools (e.g., pictures, realia, flashcards) and digital tools (e.g., mind maps, Kahoot, online quizzes), ensuring lessons are interactive, stimulating, and accessible to all students. In addition, polytechnic management should provide training programs to equip lecturers

with skills to design and implement effective visual aids, including multimedia and digital resources to enhance teaching quality and learning outcomes. Finally, future research could explore the long-term impact of visual aids on academic performance, motivation, and skill acquisition in other subjects, as well as investigate the effectiveness of emerging technologies like augmented reality (AR) and virtual reality (VR) in polytechnic education.

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The Impact of Tax Knowledge, Tax Morale, and Tax Awareness Towards Tax Compliance Behaviour Among Potential Taxpayers of Commerce Department Students in Politeknik Muadzam Shah

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Abstract

Introduction of the Self-Assessment System (SAS) in 2001 for corporate taxpayers and 2004 for individual taxpayers represented a paradigm shift in tax administration, in which students as a youth and potential tax payer in future represent a particularly vulnerable group in terms of readiness on tax compliance behaviour. This study attempts to investigate the impact of tax knowledge, tax morale and tax awareness towards tax compliance behaviour among potential taxpayers of Commerce Department Students in Politeknik Muadzam Shah. A theoretical framework was developed based on the Theory of Planned Behavior. This study applied a quantitative research design in order to identify relationship between the independent variables and dependent variable. A structured questionnaire was distributed to the 584 Commerce Department Students in Politeknik Muadzam Shah. The data gain was then been analyse by using SPSS Statistic 29 with descriptive analysis, reliability analysis, pearson correlation analysis and linear regression. The data analysis from 298 completed respondent revealed that tax knowledge, tax morale and tax awareness have significant influences on the tax compliance behaviour among Commerce Department Students as a potential taxpayers in future time. The results of this study are also in line with the Theory of Planned Behaviour, provide strong empirical evidence that all three factors significantly affect tax compliance behaviour, with tax awareness emerging as the strongest variable, followed by tax morale and tax knowledge. This present study, however, has limitations on not include students from non-commerce fields and students from other institute higher learning as this study only focused on commerce students from a single polytechnic. Other critical factors towards tax compliance behaviour such as tax complexity and tax cost were not included.

Keywords : *Tax knowledge, tax morale, tax awareness, tax compliance behaviour, theory of planned behaviour.*

I. INTRODUCTION

A. Background of the study

Taxation is universally acknowledged as a cornerstone of national development, providing governments with stable revenue streams to fund essential sectors such as infrastructure, healthcare, education, social protection, and security. A sustainable tax system not only ensures fiscal stability but also reduces reliance on volatile external borrowing or natural resource rents, thereby supporting long-term economic resilience [27]. In the Malaysian context, taxation contributes more than half of federal government revenue, confirming

its crucial role in financing national expenditure and sustaining socio-economic growth [41].

Malaysia's tax framework has undergone significant reforms aimed at strengthening efficiency and compliance. Among these reforms, the introduction of the Self-Assessment System (SAS) in 2001 for corporate taxpayers and 2004 for individual taxpayers represented a paradigm shift in tax administration. By placing responsibility for accurate self-declaration directly on taxpayers, SAS was expected to reduce administrative burdens on the Inland Revenue Board of Malaysia (IRBM) while encouraging voluntary compliance. However, the success of SAS is highly dependent on

taxpayers' tax knowledge, awareness, and moral responsibility, rather than enforcement alone.

However, implementing SAS effectively depends not only on administrative reform but also on behavioural and psychological factors. Recent research indicates that even with SAS, many Malaysians struggle with limited tax knowledge, low awareness, and inadequacies in moral motivation [21], [37]. For example, previous study found a negative relationship between tax non-compliance and both tax knowledge and awareness among potential taxpayers (final year accounting students), implying that higher knowledge and awareness reduce non-compliance [37].

Despite its potential, voluntary compliance under SAS has remained inconsistent. Empirical evidence highlights that Malaysian taxpayers continue to struggle with limited tax literacy, difficulties understanding complex legislation, and varying degrees of tax morale [35], [12]. Studies have further revealed that while enforcement mechanisms may reduce evasion, they cannot foster sustainable compliance unless taxpayers internalize a sense of civic duty and ethical obligation [27], [10]. This underscores the importance of behavioural factors in shaping tax compliance behaviour.

Moreover, complexity of tax law remains a significant barrier in which a study of SMEs in Malaysia revealed that owners find tax regulations confusing, and these complexity perceptions reduce willingness to comply voluntarily [14].

Recent scholarship increasingly emphasizes the behavioural economics perspective in taxation, pointing to the influence of attitudes, perceptions of fairness, and social norms. For instance, previous study in Asian contexts, tax morale, fairness, and institutional trust significantly predict compliance intentions, while excessive complexity undermines compliance efforts [38]. A study reported that voluntary compliance improves when taxpayers perceive both fairness in tax distribution and integrity in governance [8]. In Malaysia, where public trust in government institutions remains an important determinant, perceptions of fairness and efficiency in the use of tax revenue continue to shape compliance behaviour [25], [10].

More recently, scholars have noted that young taxpayers and students represent a particularly vulnerable group in terms of compliance readiness. Many Malaysian students possess general awareness of taxation but lack the technical

understanding needed to meet SAS requirements [43]. Similarly, strengthening tax knowledge and morale among salaried groups remains critical to sustaining SAS, findings which may be extended to future taxpayers such as commerce students [41]. These insights highlight the urgency of cultivating tax knowledge, moral responsibility, and awareness at an early stage, ensuring that the next generation enters the workforce better prepared to comply tax payment voluntarily.

B. Problem Statement

Although Malaysia introduced the Self-Assessment System (SAS) in 2001 for corporate taxpayers and 2004 for individual taxpayers, voluntary tax compliance remains a persistent challenge. Even among salaried employees who are generally expected to comply through payroll deductions, studies reveal gaps in knowledge, perceptions of complexity, and varying levels of moral responsibility. For instance, a Malaysian study found that tax knowledge, tax complexity, and tax morale significantly influence compliance behaviour under SAS, confirming that these behavioural factors remain central challenges for salaried taxpayers [41]. In order for tax knowledge motivates tax compliance, it must be supported by effective education and awareness initiatives to prevent unintentional non-tax compliance [43].

Other recent findings, however, point to deeper behavioural barriers. Young workers, enforcement mechanisms and system complexity exert stronger influence on compliance than tax knowledge or awareness, suggesting that deterrence remains more powerful than civic duty [26]. Tax awareness and knowledge show only weak correlations with compliance behaviour among Malaysian students, indicating that awareness campaigns alone may not translate into actual compliance [28]. These results contrast with earlier assumptions that improving tax literacy automatically leads to voluntary compliance.

In addition, fairness perceptions and trust in institutions strongly shape compliance decisions. Perceptions of justice and confidence in the Inland Revenue Board are vital for voluntary compliance [10]. Previous study emphasized the role of religiosity and intrinsic motivation in shaping tax morale [25]. These insights align with international evidence, such as in Cambodia [38] and in Indonesia [8], both of whom confirmed that trust, fairness, and morale are stronger predictors of compliance than technical knowledge alone.

Despite these findings, critical gaps persist. Among salaried Malaysians, tax knowledge, tax complexity, and tax morale significantly impact compliance, yet many remain non-compliant under SAS [41]. While tax knowledge is necessary, it appears insufficient alone. Observation from previous researcher that, although awareness and knowledge are negatively associated with non-compliance, many students with formal tax education still lack deep understanding of SAS procedures or penalties [37].

Young workers and future taxpayers are particularly vulnerable. For example, identification on education level, fairness perception, and institutional trust mediate between knowledge and compliance, but awareness and moral commitment are still weak among young students [21].

Prior research has examined awareness but has not fully tested how knowledge, morale, and awareness interact to shape compliance intentions under SAS [36].

Taken together, these findings suggest that while tax knowledge, complexity, and morale clearly affect compliance, less of the studies focus on students as future and potential individual taxpayer in Malaysia. For commerce students as future taxpayers, the risk is clear on limited exposure to practical tax procedures, coupled with perceptions of complexity and weak morale, may create a generation of taxpayers who comply primarily out of fear of penalties rather than intrinsic responsibility.

C. Research Context

This study is conducted among commerce students at Politeknik Muadzam Shah. These students are future taxpayers who, through their academic programmes, may have more exposure to business or accounting and thus potentially stronger knowledge and attitudes towards taxation. However, prior research suggests that even among students in accounting or business programmes, awareness, understanding, and moral motivations remain uneven [21], [37]. The choice of this population allows examination of how tax knowledge, awareness, and tax morale interact under Theory of Planned Behaviour (TPB) among upcoming and potential taxpayers in a polytechnic context.

D. Research Question

This study is guided by the following research questions:

- i. Does tax knowledge influence tax compliance behaviour?
- ii. Does tax awareness influence tax compliance behaviour?
- iii. Does tax morale influence tax compliance behaviour?

E. Objective of the study

The objectives of the study are:

- i. To examine the relationship between tax knowledge and tax compliance behaviour.
- ii. To examine the relationship between tax awareness on tax compliance behaviour.
- iii. To examine the relationship between tax morale and tax compliance behaviour.

II. LITERATURE REVIEW

A. Theory of Planned Behavior

The Theory of Planned Behaviour (TPB) has been widely used to explain and predict human behaviour across various disciplines, including taxation developed by [1]. TPB asserts that the most immediate determinant of behaviour is behavioural intention, which itself is shaped by three key components: attitude toward the behaviour, subjective norms, and perceived behavioural control. Attitude reflects an individual's overall evaluation of performing a behaviour as favourable or unfavourable, subjective norms capture the perceived social pressure from significant others to perform or not perform a behaviour, and perceived behavioural control refers to an individual's perception of their capability to perform the behaviour, influenced by access to resources, skills, and opportunities [1].

The Theory of Planned Behaviour (TPB) has been widely applied to explain tax compliance intentions and behaviours across both developed and developing countries, offering insights that support improvements in tax systems globally. TPB provides one of the most accurate theoretical frameworks for understanding tax compliance, as it incorporates important psychological and behavioural factors such as tax morale and tax

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knowledge [24]. Moreover, TPB able to explain the tax compliance behaviour by demonstrating its consistent ability to predict taxpayers' intentions and behaviours in emerging economies [38].

At its core, TPB posits that three factors determine an individual's behavioural intention: attitudes toward the behaviour, subjective norms, and perceived behavioural control [1]. When individuals have a strong intention to comply, the likelihood of actual compliance behaviour increases. In line with this, identification study on tax morale, tax complexity, and tax knowledge as significant determinants of compliance intentions under the TPB framework [38]. Similarly, researcher found that higher levels of tax knowledge, coupled with favourable attitudes toward taxation, substantially increase taxpayers' willingness to meet their obligations [4].

Evidence also suggests that tax knowledge is closely linked to taxpayers' attitudes toward tax morality, thereby reinforcing the role of TPB in connecting cognitive and ethical dimensions of compliance [40].

Recent research continues to demonstrate the relevance of TPB in explaining compliance behaviours, including taxation. tax awareness and tax knowledge significantly shape potential taxpayers' intentions [37], while other study highlighted that perceptions of complexity strongly influence small and medium enterprises' compliance behaviours [14]. Similarly, this include that tax awareness among students is influenced by subjective norms and civic responsibilities, showing that social expectations and institutional influence remain critical factors in shaping compliance [36].

Collectively, these studies demonstrate that TPB remains a powerful framework for understanding and predicting tax compliance behaviour, particularly when tax knowledge, morale, and awareness are integrated into its constructs. For this study, the TPB framework is adapted by aligning its three constructs with the variables under investigation. Tax knowledge is associated with perceived behavioural control, as individuals with stronger literacy feel more capable of fulfilling tax obligations. Tax morale reflects attitudes toward the behaviour, since intrinsic motivation and ethical considerations influence whether tax compliance is viewed positively. Tax awareness corresponds to subjective norms, as increased awareness combined with social

expectations encourages stronger intentions to comply.

Thus, TPB provides a comprehensive theoretical lens for explaining how commerce students at Politeknik Muadzam Shah may form compliance intentions as future taxpayers.

B. Tax Compliance Behaviour

Tax compliance remains a serious challenge for tax authorities around the world, and ensuring that taxpayers adhere to tax requirements is often difficult. Tax compliance is defined as taxpayers' willingness to obey tax laws to contribute toward economic balance [16], [3]. Tax compliance behaviour refers to the extent to which taxpayers follow tax laws, report income truthfully, and pay taxes within the required timeframes. The differences between voluntary compliance, which stems from taxpayers' internal motivation, trust, and civic duty, and enforced compliance, which is driven by fear of penalties, audits, or legal consequences [18].

Emphasizes on enforcement mechanisms remain necessary, sustainable fiscal systems rely more heavily on voluntary compliance because it reduces administrative costs and fosters public trust [2]. Essentially, compliance involves properly fulfilling all obligations under applicable tax laws and regulations [29]. Empirical research using the TPB framework spans many nations, including Canada Ghana, Indonesia and the United States [20], [39], [32], [8] ,[6].

In developing countries, compliance behaviour is shaped by behavioural factors such as tax knowledge, tax awareness, and tax morale.

Tax knowledge improves taxpayers' ability to comply by enhancing their understanding of rules, procedures, and obligations. Higher knowledge reduces non-compliance among potential taxpayers in Malaysia [37]. Similarly, highlighted from other researcher that when SMEs adopt IT systems and improve tax literacy, their compliance costs decrease, resulting in stronger compliance [4]. Limited knowledge, however, often produces unintentional errors and lower willingness to comply.

Tax awareness relates to individuals' recognition of tax obligations and the role of taxes in national development. Awareness campaigns and education strengthen civic responsibility and reinforce subjective norms that compliance is

expected in society. Tax awareness and education strongly influenced compliance perceptions among Malaysian SMEs [14]. Likewise, studied showed that greater awareness of obligations and enforcement improved compliance intentions in Cambodia [38].

Tax morale reflects taxpayers' intrinsic motivation and ethical values in paying taxes, influenced by fairness, transparency, and trust in government. Tax morale significantly shapes compliance behaviour among salaried groups in Malaysia [41]. Previous studies found that low tax morale, often linked to corruption and unfair practices, contributes to evasion tendencies [40].

Taken together, tax knowledge strengthens perceived control, tax awareness reinforces subjective norms, and tax morale influences attitudes toward taxation. These three dimensions are consistent with the Theory of Planned Behaviour, providing a robust framework to explain tax compliance behaviour among future taxpayer in this study.

C. Tax Knowledge and Tax Compliance Behaviour

Tax education is widely recognized as an essential tool in cultivating tax knowledge, which in turn enables individuals to better understand tax laws and regulations [9]. Tax knowledge is among the most influential determinants of tax compliance behaviour under the self-assessment system in Malaysia [22], [7], [41], [12], [26]. Conversely, inadequate tax knowledge has been associated with misreporting, errors, and even unintentional tax evasion [33].

Evidence from highly compliant nations such as Canada, the United States, Switzerland, and New Zealand suggests that embedding tax education programs early in the curriculum can significantly foster compliance later in adulthood (CIAT, 2011). Tax education is a practical approach to strengthening voluntary compliance, as it equips individuals with the necessary technical and general tax knowledge [23]. In addition, researcher from Indonesia agreed that tax education can increase tax knowledge and influence taxpayers' compliance behavior in which line with social learning theory [17].

In the Malaysian context, further empirical evidence underscores the critical role of tax knowledge in addressing compliance challenges in

which emphasized that tax knowledge represents a core element of voluntary compliance behaviour [7], [43], [35]. Tax knowledge encompasses both technical aspects such as filing procedures and reporting rules and general knowledge about the tax system [43].

Several scholars argue that investing in taxpayer education may be more effective than allocating resources to enforcement and detection [7]. Impact of tax knowledge on compliance is mixed and context-dependent [15]. Increased knowledge does not automatically translate into greater compliance, highlighting that education must be complemented by factors such as trust in institutions, tax morale, and perceived fairness of the system [12]. Building on these insights, this study proposes the following hypothesis:

H1: Tax knowledge does significantly influence tax compliance behaviour among potential taxpayers of Commerce Students in Politeknik Muadzam Shah.

D. Tax Morale and Tax Compliance Behaviour

Tax morale is an important behavioural factor influencing tax compliance, reflecting taxpayers' intrinsic motivation, ethical values, and attitudes toward fulfilling tax obligations [27], [25]. In Malaysia's self-assessment system, taxpayers are responsible for self-declaration, but compliance is often undermined by perceptions of unfairness and inequality. Studies suggested tax morale is related to tax compliance behaviour [25]. Other findings confirmed that positive perceptions of justice and trust in tax authorities foster compliance, whereas declining trust weakens confidence and leads to immoral tax behaviour [10], [41], [12], [26].

Research further shows that tax morale is shaped by both internal and external factors. While moral values, religiosity, and personal ethics create intrinsic motivation, external influences such as governance quality, equitable treatment, tax authority behaviour, cultural norms, and social expectations also play a significant role [30]. Social norms and religious values, in particular, provide strong moral grounding for tax compliance, with taxpayers often perceiving payment as a civic duty and moral responsibility. Improvements in governance and fair treatment by authorities have been found to encourage voluntary compliance.

Knowledge also strengthens tax morale by increasing awareness of taxation's role in financing

national development [12]. Building on these insights, this study proposes the following hypothesis:

H2: Tax morale does significantly influence tax compliance behaviour among potential taxpayers of Commerce Students in Politeknik Muadzam Shah.

E. Tax Awareness and Tax Compliance Behaviour

Taxation is a fundamental source of revenue for governments worldwide, including Malaysia, where it represented 74% of national income in 2018 [5]. A critical element in ensuring compliance is taxpayers' knowledge of taxation systems, such as the Self-Assessment System, which helps improve voluntary compliance [30]. Tax awareness considered as important element in tax compliance behaviour, which scholars have defined in various ways. Tax awareness is defined as the ability to calculate, pay, and report taxes, additional as a cognitive process of recognizing the need to pay taxes and adhere to regulations [13], [42]. Tax awareness seen as an additional factor shaped by beliefs and reasoning that influences tax compliance behaviour [33].

Tax awareness benefits taxpayers by improving their ability to fulfil obligations, whereas limited awareness often leads to reluctance or avoidance of payment, whether intentional or not [34]. In Malaysia, low tax awareness has been associated with higher tax non-compliance, but literacy and education initiatives can strengthen the tax compliance [13]. Studies show that both tax knowledge and awareness play influential roles in tax compliance behaviour [31]. Building on these insights, this study proposes the following hypothesis:

H3: Tax awareness does significantly influence tax compliance behaviour among potential taxpayers of Commerce Students in Politeknik Muadzam Shah.

Based on the above discussions, Figure 1 below is developed to illustrate the theoretical framework which presents the relationship between independent and dependent variables.

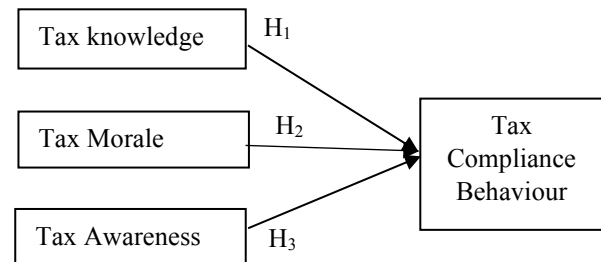


Figure 1: Theoretical Framework

III. RESEARCH METHODOLOGY

The present study focused on Commerce Students from session Sesi 2: 2024/2025 in Politeknik Muadzam Shah, Pahang. The students are selected as basis they are pursuing a Diploma in Business Studies and Diploma in Accountancy, in which these students are highly knowledgeable potential taxpayer in future either for pay tax own business or as individual tax payer. The questionnaire was distributed to the population of 584 students and collection of 298 respondents were received. Referring to table for determining sample size for a population of 600 students, a sample of 234 is sufficient to cross-reference the population [19]. Therefore, the sample of 298 is sufficient to cover the entire population. As a result, for this study, the response rate was 51% of the students (298 out of 584 students were invited), which exceeds the threshold of 30%, as suggested by [11].

The present study implemented a non-probability sampling method and the collection of data is conducted via a developed structured questionnaire. These questionnaires are distributed to all 584 students of Commerce Department during Session 2: 2024/2025 via online platform of Google Forms.

As for research instruments, the present study uses survey questionnaires to identify relationships between the constructs. The questionnaires employed in this study are adopted from empirical studies as it focused on tax compliance behaviour [36], [41], [14].

The questionnaire contains two major sections, the first section collects the demographic information about the respondents, while the second section comprises questions regarding three factors

which are the tax knowledge, tax morale, tax awareness towards tax compliance behaviour. The study employed a corresponding 5 Likert scale (1 for “Strongly Disagree”; 2 for “Disagree”; 3 for “Neutral”; 4 for “Agree” and 5 for “Strongly Agree”). The variables and questions are shown in Table 1.

In order to gain a comprehensive understanding of the data set, descriptive analysis, reliability analysis, pearson correlation analysis and linear regression was performed using SPSS, which involved calculating measures such as means, standard deviations, frequency and percentage to summarize and present key characteristics.

Table 1: Research Variable

Variables	Items	Questions
Tax Knowledge (TK)	TK1	I know that the LHDN is the agency that handles direct tax in Malaysia.
	TK2	I know that the Royal Malaysia Customs Department is the agency that handles indirect tax in Malaysia.
	TK3	I am familiar with how to file a personal income tax return in Malaysia.
	TK4	I know that we need to submit tax file every year.
	TK5	I know that there are several types of tax relief provided to reduce the burden on taxpayers.
	TK6	I know that buying books and education fee can reduce the tax amount payable to the government.
Tax Morale (TM)	TM1	I believe paying taxes is a duty that every citizen should fulfill.
	TM2	I believe that as a citizen, we need to follow all rules and

		regulations related to tax.
	TM3	I would still pay taxes honestly even if the chance of getting caught by authority is low.
	TM4	I will voluntarily comply with the tax law.
	TM5	I believe that tax avoidance is unethical for everyone.
	TM6	I believe paying taxes contributes to the well-being of society.
Tax awareness (TA)	TA1	Tax awareness should start from the young age.
	TA2	I am aware that the tax collection will be used for the social economic development in the country such as healthcare and education.
	TA3	I am aware of the penalties for not paying or avoid payment of taxes in Malaysia.
	TA4	I believe being informed about taxation is important for all citizens.
	TA5	I am conscious of my future responsibilities as a taxpayer when my income reaches the threshold amount.
Tax Compliance Behaviour (TCB)	TCB1	I intend to comply with tax laws once I enter the workforce.
	TCB2	I plan to file my tax returns accurately and on time in the future.
	TCB3	I will pay the correct amount of taxes even without being audited.
	TCB4	I believe I will continue to comply

		with tax laws throughout my life.
	TCB5	I would encourage others to be tax-

		compliant as part of responsible citizenship.
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IV. RESULT AND DISCUSSION

A. Socio-Demographic Characteristics

Table 2 demonstrates demographic data extracted from the present study. As indicated below, a total of 218 (73%) respondents from this study are female, while the remaining 80 (27%) respondents are male. 119 (40%) respondents are Commerce Students from Diploma Business Studies, while remaining of 179 (60%) respondents are Commerce Students from Diploma Accountancy. Total of 40 (13%) respondents are Commerce Students from Semester 1 and 2, 100 (34%) respondents are Commerce Students from Semester 3 and 4, 158 (53%) respondents are Commerce Students from Semester 5 and 6. In total, 214 (72%) of all the respondents have learned and attend any tax-related course or class during studies, while remaining 84 (28%) respondents never learned and attend any tax-related course or class during their studies.

Table 2: Demographic Characteristic of Respondents

<i>Gender</i>	<i>Number</i>	<i>Percentage (%)</i>
Male	80	27
Female	218	73
Total	298	100
<i>Program Studies</i>	<i>Number</i>	<i>Percentage (%)</i>
Diploma Business Studies	119	40
Diploma Accountancy	179	60
Total	298	100
<i>Semester</i>	<i>Number</i>	<i>Percentage (%)</i>
Sem 1 & 2	40	13
Sem 3 & 4	100	34
Sem 5 & 6	158	53
Total	298	100
<i>Learned and attend any tax-related course</i>	<i>Number</i>	<i>Percentage (%)</i>
Yes	214	72
No	84	28
Total	298	100

B. Descriptive Analysis

Table 3 shows the descriptive statistics of variable to measure the variables of research. The gather data was organized into statistical tables and subjected to mean analysis. Mean value of 2.50 and above were viewed as positive or accepted, while a score with less than 2.50 were seen as negative and unaccepted answer, as suggested by [44].

For tax knowledge variable result in table 3 indicates the low score on familiarity of process filing personal income tax. It shown that most of the respondents among Commerce Students have lack of knowledge on the procedure in filing personal income tax return in Malaysia. The same low score is also recorded in variables tax morale of honesty of the respondents to pay tax in future. This score indicates that respondents might have honesty issues in paying tax as potential taxpayer.

The low score of mean analysis in tax awareness variables indicates that respondents have lack awareness on degree of penalty imposed in case of not paying tax in the future. Low score in mean analysis on tax compliance behaviour also shown that there are possibility among Commerce Student in Politeknik Muadzam Shah as respondents might pay the incorrect amount of taxes in future.

Table 3: Descriptive statistics of variable to measure the variables of research

Variables	Items	Mean	Std. Deviation	N
Tax Knowledge (TK)	TK1	4.49	.730	298
	TK2	4.07	.962	298
	TK3	3.25	1.131	298
	TK4	4.13	.982	298
	TK5	4.14	.921	298
	TK6	3.96	1.069	298
Tax Morale (TM)	TM1	4.38	.783	298
	TM2	4.53	.652	298
	TM3	4.23	.788	298
	TM4	4.30	.767	298

	TM5	4.26	.864	298
	TM6	4.40	.760	298
Tax awareness (TA)	TA1	4.42	.754	298
	TA2	4.33	.756	298
	TA3	4.14	.876	298
	TA4	4.35	.751	298
	TA5	4.33	.765	298
Tax Compliance Behaviour (TCB)	TCB1	4.34	.740	298
	TCB2	4.28	.779	298
	TCB3	4.23	.824	298
	TCB4	4.32	.718	298
	TCB5	4.34	.759	298

C. Reliability Analysis

All data variables collected from questionnaires has been match with reliability statistics of Cronbach's Alpha. Total 22 question in this study show the reliable internal consistency of set of data in testing items as design. A higher alpha value of above 0.70 indicates that the items in all variables are highly correlated, in which respondents respond the question similarly. The results in table 4 indicates that Commerce Students in Politeknik Muadzam Shah show the Cronbach's Alpa for all variables of Tax Knowledge, tax Morale, tax Awareness and Tax Compliance Behaviour show the score of more than 0.70. Therefore, based on the analysis of Cronbach Alpha that using SPSS it explained that significant value of Cronbach Alpha from all variables were correlated and achieved.

Table 4: Reliability Statistics

Variables	Items	Cronbach's Alpha
Tax Knowledge (TK)	TK1	0.851
	TK2	
	TK3	
	TK4	
	TK5	
	TK6	
Tax Morale (TM)	TM1	0.917
	TM2	
	TM3	
	TM4	
	TM5	
	TM6	
Tax awareness (TA)	TA1	0.898
	TA2	

	TA3	
	TA4	
	TA5	
Tax Compliance Behaviour (TCB)	TCB1	0.937
	TCB2	
	TCB3	
	TCB4	
	TCB5	

D. Pearson Correlation Analysis

Table 5 below was developed using SPSS to show Pearson Correlation on explaining the relationship result between independent variables of Tax Knowledge, Tax Morale and Tax Awareness towards dependent variables of Tax Compliance Behaviour.

Table 5: Pearson Correlation Analysis

Variables	Tax Compliance Behaviour	Tax Knowledge	Tax Morale	Tax Awareness
Tax Compliance Behaviour	1.000	0.618	0.807	0.891
Tax Knowledge	0.618	1.000	0.692	0.595
Tax Morale	0.807	0.692	1.000	0.847
Tax Awareness	0.891	0.595	0.847	1.000

The Pearson correlation analysis in Table 5 indicates that Tax Compliance Behaviour (TCB) has the strongest positive association with Tax Awareness (TA) ($r = 0.891$), followed by Tax Morale (TM) ($r = 0.807$), and Tax Knowledge (TK) ($r = 0.618$).

The strongest relationship was found between Tax Awareness (TA) and Tax Compliance Behaviour (TCB) ($r = 0.891$), which reflects a very strong positive correlation. This indicates that Commerce students who are more aware of tax obligations such as the purpose of taxation, deadlines, and reporting requirements are more likely to Tax Compliance Behaviour. Awareness represents the cognitive recognition of the importance of taxes as a civic duty [13], [33], [42].

This finding aligns with other studies who confirmed that awareness is a key determinant of non-compliance reduction, especially among potential taxpayers who are new to the system [28], [37]. Similarly, other study demonstrated that higher education exposure enhances awareness, acting as a moderator that strengthens compliance behaviour among students [36]. These studies suggest that tax awareness campaigns and educational modules targeting young taxpayers can be one of the most effective strategies in building sustainable compliance.

The second-strongest correlation emerged between Tax Morale (TM) and TCB ($r = 0.807$), showing that ethical values and civic responsibility strongly influence students' compliance.

This result is consistent with who highlighted the role of justice perception and trust in driving compliance, as well as previous empirical evidence on how religiosity and moral values shape positive tax attitudes in Malaysia [10], [12], [25]. Other researcher also argued that reducing uncertainty and building trust strengthens tax morale [8], [41]. Together, these findings suggest that compliance cannot be sustained through enforcement alone; rather, trust in institutions and fairness in tax administration are essential in building voluntary compliance.

The correlation between Tax Knowledge (TK) and TCB ($r = 0.618$), while weaker than Tax Awareness and Tax Morale, remains statistically meaningful. Knowledge involves understanding tax laws, filing procedures, and the consequences of non-compliance [35]. The positive correlation implies that students who understand the technical aspects of taxation are more likely to comply, though knowledge by itself may not guarantee compliance.

This supports the findings who noted that self-employed taxpayers with greater knowledge exhibit higher compliance [12], [41].

These Pearson Correlation findings strongly support the Theory of Planned Behavior where behaviour is driven by attitudes (morale), subjective norms (awareness of societal expectations), and perceived behavioural control (knowledge) [1]. This suggests that an integrated behavioural model best explains students' future tax compliance.

E. Hypotheses Testing Linear regression

Table 6: Hypotheses result using linear regression

Hypotheses	Std Error	P-Value	Decision
H1	0.027	0.000	Supported
H2	0.047	0.000	Supported
H3	0.050	0.000	Supported

The linear regression results in Table 6 demonstrate that all three hypotheses (H1, H2, and H3) are statistically significant and supported, as indicated by very small standard errors (ranging from 0.027 to 0.050) and p-values of 0.000. This implies that the predictors proposed in the study such as tax knowledge, tax morale, and tax awareness exert a meaningful influence on tax compliance behaviour. The findings are consistent with previous research which highlights the importance of trust and fairness in shaping tax compliance behaviour decisions, as well as the role of individual determinants such as tax knowledge and awareness among Malaysian taxpayers [8], [10], [21], [28], [37]. Among students and young taxpayers, awareness and educational exposure are proven to strengthen voluntary compliance [36], [26], [14], [41]. Therefore, the supported hypotheses confirm that enhancing knowledge, strengthening morale, and increasing awareness can significantly reduce non-compliance and foster tax compliance behaviour, aligning with the theory of planned behaviour and extending prior evidence in both Malaysian and international contexts [35], [29], [12].

V. CONCLUSION, LIMITATIONS AND FUTURE RESEARCH

This study set out to examine the influence of tax knowledge, tax morale, and tax awareness on tax compliance behaviour among commerce students at Politeknik Muadzam Shah. The results of this study are also in line with the Theory of Planned Behaviour, with strong empirical evidence that all three factors significantly affect tax compliance behaviour, with tax awareness emerging as the strongest variable, followed by tax morale and tax knowledge.

While this study contributes important insights into the relationship between tax knowledge, tax morale, and tax awareness towards compliance behaviour among commerce students at Politeknik Muadzam Shah, several limitations must be acknowledged. First, the study is limited in scope as it only focused on commerce students from a single polytechnic, which may restrict the generalizability of the findings to students in other disciplines, institutions, or working adults with varying levels of tax exposure. Moreover, the study examined only three behavioural determinants under the Theory of Planned Behaviour, while other critical factors towards tax compliance behaviour such as tax complexity and tax cost were not included. Finally, this study did not test moderating or mediating effects, such as whether trust in institutions amplifies the role of morale or whether awareness mediates the effect of knowledge on compliance.

These limitations open several avenues for future research. Expanding the sample to include students from non-commerce fields, and variety of polytechnic in Malaysia in which would increase the generalizability of results across different potential taxpayer groups. Future studies should also integrate institutional variables such as perceptions of fairness, law complexity, enforcement strength, and digital filing systems to better explain compliance behaviour. Testing for moderating and mediating effects would provide a more nuanced explanation of how behavioural factors interact. Lastly, comparative studies across ASEAN or other regions could highlight cultural and policy differences, enabling Malaysia to benchmark its strategies and strengthen sustainable voluntary compliance.

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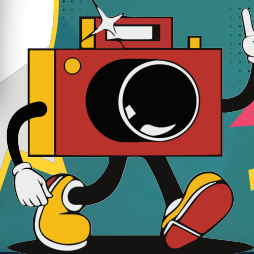
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INNOVATION TOWARDS KEY PERFORMANCE INDICATORS (KPI)

**PERTANDINGAN INOVASI PEMBELAJARAN DAN PENGAJARAN
PERINGKAT KEBANGSAAN**

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TAJUK INOVASI/INNOVATION TITLE
3R DAN UPCYCLING
THE HEART HIGHWAY
EBCKAK
JAYDEN'S STORY BOARD GAME
HERBAL SANITIZER
PIRATE TALES
VOLBOOM!
KOMPONEN TELINGA MENGIKUT TURUTAN
SMART AGRICULTURE WITH ARDUINO TECHNOLOGY
HYDRODETECTOR
LEARNIFY ARM
IOT INNOVATORS OF TOMORROW
SIMEPLAY OBBY
APLIKASI E-CAKNA BAHASA
GUNTING KESELAMATAN AUTOMATIK
EMBRACING THE FUTURE OF EDUCATION
HOUSE FOR NUMBERS
PENDEKATAN TEKNIK VIDEO GURU MUDA MEMBANTU PELAJAR SVM LEBIH MEMAHAMI SUBJEK MATEMATIK DI KOLEJ VOKASIONAL KUALA KANGSAR
MENGAPLIKASIKAN SISTEM COLOUR-CODED DAN GAMIFIKASI DALAM PENGURUSAN DOKUMENTASI PELAJAR PENGURUSAN PERNIAGAAN
PENGUNAAN KAMUS 3D UNTUK MENINGKATKAN PENGUASAAN MUFRADAT BAHASA ARAB DALAM KALANGAN PELAJAR DIPLOMA KOLEJ VOKASIONAL KUALA KANGSAR
DIFEMOD
EP WHEEL
AAT DAN DIGITAL UNTUK DISLEKSIA
KAD POP-UP OPERASI MATEMATIK
PENGUASAAN MENULIS ANGKA PERKATAAN MURID PENDENGARAN
PAIP HAFAL BIJAK
KIT FIND ME
THE DROAZNOLOGY METHOD IN LEARNING SCIENCE
KOMIK JEJAK ANOD DAN KATOD
RODA IMPIAN NILAI MORAL 8K
GAME LEARNING HANI TRUE MATCH
SAINS MANIA
KIT INTERAKTIF DINAMIK (KIDI)
JVO KIT (JEJARI VOKAL)
ANINO! GAMIFIKASI DUNIA HAIWAN
WEBSITE;WANTDEVELOPMENT
KIT DWIGANDA
KIT PERMAINAN VOKAR
EASYTPM-CALC
I-STEM EDUWHIZ RC DRIVE

TWO MINUTES TWICE DAILY
RUMAH IMPIAN DINI
RUMAH IDAMAN MESRA ALAM
MY JOY ZONE
PENYAPU ELEKTRONIK
UNLOCKING LEARNING THROUGH AR
THE RAINBOW ALPHABET
EGGSHELLS NATURE'S PEST DETERRENTS FOR SLUGS AND SNAILS
SMART RAINBOW UMBRELLA
ONE STOP CENTRE HAIWAN KOH
ROBOT PENUNJUK ARAH ORANG BUTA
KAD SIFIR TAHAN LASAK
SMART WIND NAZFAD
MINI VACUUM DARI BAHAN TERPAKAI
GEDUCLASSROOM (GOOGLE EDUCATION CLASSROOM)
LENG-AT 2.0
USE-ME-BOARD ENHANCES SCIENCE LEARNING
MUDAHNYA BINA AYAT 'SPOK TMK'
LAMAN WEB 'PRO-BMC'
E-CAR CONDUCTOR & INSULATOR DETECTOR
APLIKASI WECARE MENAMBAHBAIK AMALAN PROMOSI PERKHIDMATAN B&K
SVI MEKANISME PERTAHANAN BADAN
MODUL INQ-TLBT
BATS
BEE COUNTING QUEST
BISMA (BUILDING SERVICES MADE ACCESSIBLE)
M-SIRI: MITOSIS VS MEIOSIS
INTERACTIVE MAGNETIC IMPEDANCE KIT (IMI KIT)
HAFAZ HERO
WUDHU QUEST
FOOD WASTE TO FIBER THE USED OF BANANA PEELS IN SUSTAINABLE PAPER RECYCLING
SAFE EMOTIONAL ESCAPE DEN (SEED)
KIT IDC
KIT SIBUDIK-BEZ
INOVASI KAD MENGINGAT FDL
CIKGU AI LIVESAVER
KID SVOQOA
BIJAK ESEI MORAL MELALUI JADUAL ACMOD
MYSPT.V4
MEAT SMOKING CHAMBER
RAINBOW WORKSHEET (RAWO)
KIT IDC
BARWARNI

PENGUNAAN KAEDAH TABLE OF GUIDANCE (TOG) 2.0 DALAM
MENINGKATKAN PENGUASAAN MURID DALAM OPERASI ASAS BAHAGI
TEKNIK CASBAPT UNTUK MENGHASILKAN PENULISAN
INOVASI V-CAN
PROJEK BUKU BIRU MNEMONIK
KEYCHAIN BODY
TICTACTOE UNTUK PERSAMAAN LINEAR (TFLE)
TICTACTOE UNTUK PERSAMAAN LINEAR (TFLE)
T10K1
MODUL BERPOLA
TICTACTOE FOR LINEAR EQUATIONS (TFLE)
MY SEJARAH
DIGIREKA: RBT DALAM GENGAMAN
MOBILE PHONICS
LITAR INTERAKTIF BERDASARKAN TEKNOLOGI AR
LITAR INTERAKTIF BERDASARKAN TEKNOLOGI AR
KIT POP
SMART CARD DIGITAL SWITCHBOARD
"TESTLAA KIT – AN ALTERNATIVE TO LITMUS PAPER"
TATABOX (KOTAK BIJAK TATABAHASA)
FUN EG
RAINBOW WORKSHEET (RAWO)
USE-ME-BOARD ENHANCES SCIENCE LEARNING
KIT LIMA-DE
DETEKTIF CILIK: MENCARI NOMBOR HILANG
RUMAH TOPULA
KIT BENANG & WARNA
MODUL LATIH TUBI BERSASAR MURID
KIT MAGIC COLOURS: MEMBANTU MURID MENGENALPASTI TIGA WARNA
ASAS DENGAN OBJEK YANG SAMA
GADGET EZ-X
M.A.S.A.K MODUL AMALI SPESIFIK ANAK KHAS
INOVASI EKSPLORASI NOTE & BUZZER BALL QUIZ
SMART PRA DIGITAL HUB
BOX JOMBA
KUASAI HURUF,BACAAN DENGAN 'WORDZO'
POLYMIND AR
EKSPLORASI KATA ARAH
SMART7 BITS
5PM
MATH TUNNEL
MULTIPURPOSE TROLLEY
EKSPLORASI KATA ARAH
KEM KALKULATOR
PRESSVIEW AR

KAD SASARAN
INNOVATE TO EDUCATE
MODUL LATIHAN 5 COLOURS EM
SENTENCE-BUILDING BOARD GAME
ROLL MAT
INTERACTIVE SIMULATOR FOR MICROPROCESSOR LEARNING
SMART RAPID PROTOTYPING
KEM KALKULATOR
KEBERKESANAN SET KAD GAGAS
DIMENSI MIRALA
DB MASTERQUEST: INTERACTIVE DATABASE LEARNING JOURNEY
BISKUT STEAM CILIK
SANGKAR PENIMBANG PUYUH MESRA PDP
NOTEWISE
MYGANTT CHART
KELAN KELIBRA
FLORALIGN: STRUKTUR ASAS GUBAHAN
MAGCLEAN
SUPER CLEANING TOOLS
TEKNIK B-SQUARE
OCTOPUS NUMBERS
ONACA
AQUABILLIONAIRE
ADA
BIJAK
MINDSPARK
KAEDAH LEOAN DAN TENAO REDOKS KIMIA
STANDARD HOLE
PORTAL ILMU MATEMATIK SVM (PIMSVN)
MATHSTAR
MODUL IRAMA BAHAGI INTERAKTIF (MIBI)
SIMPLE THREAD
ILY SIGN
PEMBASMIAN MONSTER BUNDAR
E-TOH 2.0
PERMAINAN SILANG KATA AJAIB
SMART-MAP
KIT CERDIK KNX
LAMPU AJAIB
DETECTIVE KIT
KPLOT
MODUL MAKHRAJ PINYIN
MODUL CELIK REFLEKSOLOGI
PIVOT MAKER

PIVOT MAKER
SMART TEDDY
TURN & HOP
EQ-XPEDITION (EQUATION EXPEDITION)
TANGAN AJAIB
PENGUNAAN DADU BERGAMBAR DAN BERWARNA
KAD PEAJAT
2T
KAD PEAJAT
21ST CENTURY FEED ME BOX
H2O CIRCLE
SMART EDU COOL
MAZE TAMIL: INOVASI PEMBELAJARAN DIGITAL
RASE-CARD SPECIAL EDITION
PERMAINAN KAD 'OH-SEM!' - SERONOKNYA SAINS!
ECOMATHS TAMBAH DAN TOLAK
21ST CENTURY FEED ME BOX
ECOMATH TAMBAH DAN TOLAK
STEM LEARNING THROUGH DIGITAL STORYTELLING
FLASHCARDS SMART NILAM
GOLDEN PASTRY TOUCH (GOPATO)
21ST CENTURY FEED ME BOX
ENDOPBAV
MOON CYCLE : THE MENSTRUAL WHEEL
BANK HAYAT AA- ANTIGEN ANTIBODI
BINGO AGOGO
ACCONTRANCE
ALOEBETLE GUARD
CALCIGROW
CINNACLOVE WELLNESS
CALSEED
EZ HISTORY A+
SRATE
WIFI EDUCATION KIT FOR SMARTHOME
SILANGKATA KSK
G-RAINBOWSOAP
CB-SOAP
KPM (KAD PENYELAMAT MURID)
YES ETN
BINGGO AGOGO
ABBAD 2.0
ABBAL2.0
JAM ASAS KU
ULANGKAJI MINIMUM, INGATAN MAKSIMUM

SUBSET SUNSET
NAFAS
BIOTECH_AIRPURIFIER
AEROCLEAN
DINO MATH
MOONLIGHT LAMP
GAMIFIKASI MATEMATIK BERASASKAN TOPIK INTEGER
SMART ATTENDANCE LEARNING SYSTEM
SATLE-LAB
CARI ISTILAH TOPIK KEBARANGKALIAN
DALORES
STESEN 5
SIFU MERAMAL KERTAS A03201
ECOSMART SOLAR COOLER BOX
SALTE-LAB
KAD CAS UNO
KAD CAS UNO
KAPUS 360
JARAH (JARUN ARAH)
LAMAN SIRAH NABI
KATLONIX DAN ANINOVA
BERNOULLI REVERIE
KAHOOT! RACE TO THE FINISH
SLOT 5 MINIT MATEMATIK
UNITCIRCLE
INOVASI PENDIDIKAN MORAL BAB 13
INOVASI AKROGO
SISTEM RESPIRASI 3D
AQUAREVO
SUHU PINTAR RUMAH MINI
SISTEM RESPIRASI 3D (VALID)
BIO TWIST
ENCO BALL
KDG LETS MOVE
ROBOTIC HAND GRIPPER
PLAYFUSION
LIFE TO SCIENCE METHOD
SILANGKATA TOPIK SETS
EDUBLOCK PHYSICS: INTERACTIVE TOWER OF LEARNING
SILANGKATA TOPIK SETS
KAD CAS UNO
RODA PUTAR 18 NILAI MORAL
MORUNO
PERMAINAN MORAL LALUAN LAUTAN

SEBESTARI SMART BLOODDO
SEL SEBAGAI UNIT ASAS HIDUPAN
SUP SEJARAH: PERMAINAN MUDAH HAFAL FAKTA
1 KATA, 7 KERAJAAN: INOVASI KIT HAFALAN SEJARAH ALAM MELAYU
THE LOCUS TABLE: HAFAL 5 JENIS LOKUS DENGAN MUDAH
SI POKET: INOVASI ABB AYAT GRAMATIS
GUESS AND GROW
ROBLOX MATEMATIK TAMBAHAN
SMOKE DETECTOR EXHAUSTFAN WITH IOT
HISTORY WHISPERS : PUZZLE CASE FILE
HISTORY BINGO
INOVASI HISTROBOX
PENYIRAMAN POKOK AUTOMATIK
HISTOBOX
INOVASI HISTOBOX
IKATAN ION&IKATAN KOVALEN
E-BINGO MORAL
WWTBA MORALAIRE
SIMULASI INTERAKTIF RAYRULER
CARTA SISTEM SURIA KITA
MECHALCHEMY E-MODULE FOR PHYSICAL CHEMISTRY
PERMAINAN PERIOZZLE: JADUAL BERKALA UNSUR
PERMAINAN PAPAN ARABIQUE SAFARI
KEMBARA KONVO
DISC-CUTTER MEASUREMENT TOOLS (DCMT)
NOTA DIGITAL DENGAN KOD QR
MINI PROTOTYPE SOLAR CHARGER
THERMAL EQUILIBRIUM CONCEPT
THERMODYNAMICS
NUKLEAR DI SEKELILING KITA
AUDIT APPROACH & COMPUTER-ASSISTED AUDIT TECHNIQUES
KIT JEJAK HAIWAN
LEADERSHIP ROLE PLAY KIT
KAJIAN KUALITI PRODUK SYARIKAT SAMSUNG
WRG - WINGS REPELLENT GUARD
OPS - OIL PALM SHIELD
DEEPEASE - HERBAL MASSAGE OIL
DEVELOPING AUTOMIC COMICS FOR 2D AUTOCAD
GALERI TOKOH MALAYSIA
TEKNIK B-SQUARE
HOBI DAN BELAJAR
0167027344
TROLI PENGANGKAT PAIP
ELECTROCHEM MASTERS: REDOX RUMBLE

INNOVATION OF SOLAR OVEN
NECOLL MEMBANTU PELAJAR FESYEN KVKK
E-KOMIK
SHELL TART BERASASKAN TONGKOL JAGUNG
SERUNDING BEETROOT
COFFEE COASTER
GRAMMAR MASTER
GRAMMARCADÉ
INTER: SCIENTIA
S-HAF - (SMART HAFAZAN)
JELAJAH CILIK
OCCUPATION THEME KIT
CAPTUREXL - ECOLENS: A CREATIVE RECYCLING JOURNEY
SMART FINGER KVSAS
BIO-NATURE SCRUB
A H PRO PELLET
PROQUIP
SHAMPOO FORMULATION FROM HIBISCUS EXTRACT
SOLAR WONDER
POKET PENBIL
PEMBELAJARAN HIBRID MENGGUNAKAN PENDEKATAN AKTIVITI HANDS-ON MECHMO KIT DAN GAMIFIKASI MECHMO DALAM MEKANISME TINDAK BALAS
AKADEMI GOKATIF
SAHIBBA PERJALANAN IMAN
LUXTAP NFC - TOUCH DIGITAL REVOLUTION
PENAMBAIKAN MOTOSIKAL
PENGEMBARAAN RUKUN NEGARA
ASSIGMENT SPLITTER
E-PROGRAMMING
FUN LEARNING BOX
YOGA- S.T.R.E.A.M. + KIT FOR ADHD LEARNERS
KNX EDU KIT
DT KT ACCGEN
EASY LIFTING CONCRETE MIXER
A.U.R.A: AQUEOUS-SOLUBLE UPCYCLED RENEWABLE ALTERNATIVE WRAPPING
AQUAFERA
AQUAKENKO
ROYAL FINANCE
SCHOOLYHOOPS
DT KT ACCGEN
SUARA DI BELAKANG PINTU
CABARAN JENGA 2.0
CROQUEZY

ABBM PSICHART
BLOOMWELL: GUIDING EVERY UNIQUE JOURNEY
ANDROID APPLICATION DEVELOPMENT FOR SPOT SPEED STUDY (I-SPOT SPEED)
LETRIC CHESS
SMART MATH
PEEL & REVEAL: THE HUMAN BODY UNFOLDED
COOLER MINI FAN
VIRTUAL FRONTIERS
VIRTUAL FRONTIERS
MULTIPLY THE "SQUID GAME" WAY
SMARTBOX
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TOLAK MAGIK
TALKING HOUSE
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TEKNIK CASBAPT UNTUK MENULIS CERITA
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