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Article

Market Analysis with Business Intelligence System for Marketing Planning

Treerak Kongthanasuwan [1], Nakarin Sriwiboon [2], Banpot Horbanluekit [3], Wasakorn Laesanklang [4,5] and Tipaluck Krityakierne [4,5,*]

[1] School of Bioinnovation and Biobased Product Intelligence, Faculty of Science, Mahidol University, Bangkok 10400, Thailand
[2] Compact International (1994) Co., Ltd. (Head Office), Khao Yoi, Phetchaburi 76140, Thailand
[3] National Science and Technology Development Agency (NSTDA), Thailand Science Park, Pathum Thani 12120, Thailand
[4] Department of Mathematics, Faculty of Science, Mahidol University, Bangkok 10400, Thailand
[5] Center of Excellence in Mathematics, Commission on Higher Education, Bangkok 10400, Thailand
* Correspondence: tipaluck.kri@mahidol.edu

Abstract: The automotive and auto parts industries are important economic sectors in Thailand. With rapidly changing technology, every organization should understand what needs to be improved clearly, and shift their strategies to meet evolving consumer demands. The purpose of this research is to develop a Business Intelligence system for a brake pad manufacturing company in Thailand. By analyzing the relationship between market demand and supply components of the company through regression analysis and the principles of the marketing mix, we develop a product lifecycle curve for forecasting product sales. The developed system increases the workflow efficiency of the case study company, being able to simplify the traditional data preparation process that requires employees to collect and summarize data every time a request is made. An intelligence dashboard is subsequently created to help support decision-making, facilitate communication within the company, and eventually improve team efficiency and productivity.

Keywords: business intelligence; marketing mix; business analytic; regression; product life cycle

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1. Introduction

The automotive and auto parts industries are extremely significant to Thailand's economy, being the largest commercial vehicle manufacturer in ASEAN and the 13th largest automotive part exporter in the world [1]. With today's evolving technology and extreme business competition, organizations need to adapt in order to survive by finding out what customers really want and solving problems and making decisions promptly and efficiently. Database design and management for supporting business decision-making is a difficult and complex task. Several factors influence business decisions, for instance, customers, products, costs, production, suppliers, raw materials, finished goods, employees, and other external factors that affect business operations. Database management and data analysis can be challenging for organizations with multiple functional contexts and dimensions [2]. In the digital era, collected data are often unstructured and huge in volume, making the data very difficult to deal with when using traditional data management methods. The exponential growth of unstructured, heterogeneous, and poor-quality data poses challenges in data management and hinders an organization's ability to manage and utilize information effectively [3].

Many organizations are currently confronted with the challenge of analyzing and transforming large, diverse, and complex data into a form of knowledge or information valuable to the organization in order to support decision-making in business operations. In this research, we use a case study of a brake pad manufacturing company in Thailand. The

factors that affect the company's decisions are divided into several components, including customers, usage characteristics, products, sales teams, vehicle sales in Thailand, product sales, and other external data that affect business operations. Analyzing data relevant to corporate decision-making entails taking the relationship between each data set into account. According to the auto parts industry report [4], demand for Replacement Equipment Manufacturer (REM) parts will continue to grow due to the cumulative number of the national vehicle fleet. In addition, as replacement parts are consumable, the age and mileage of vehicles directly affect the demand for the products. It revealed that the demand for REM parts has an impact on product sales in this industry.

Referring to the product sales report of the case study company, product diversification and product sales tend to rise each year, resulting in big and highly complex data. However, currently, the company does not have an efficient data collection system, resulting in the data being stored in different places or data redundancy, where the same piece of data is stored in two or more separate places. The absence of a database management system requires the employee to create a summary each time the data is requested. Using the information system that we have developed and considering whether it suits the nature of the company's business operations, we expect that the company will be able to access and utilize information in a prompt manner, leading to timely business decision-making.

The primary objective of this study was to create a database and a business dashboard to visualize brake pad demand and sales volume in order to support marketing planning decisions. This objective was achieved by implementing a Business Intelligence (BI) system for the case study company. Since the adoption of BI in the area of automotive parts is still under-researched, a secondary goal of this study was to therefore contribute to the little that is known about the advantages of BI in the automotive parts industry.

We now provide some background information and outline an overall framework for conducting research and implementing the BI. As the shape of the brake pads depends on the car model, when a specific car model is discontinued, market demand for a specific brake pad model will remain stagnant for a while before starting to decrease as soon as the vehicle begins to disappear from the road. In order to analyze the relationship between brake pad demand and product sales and forecast the progression of product sales volume, we used a Box–Cox regression model. In particular, we investigate if the company's product sales increase as a (possibly non-linear) function of customer demand according to the industrial mechanism. Subsequently, the product lifecycle was created and used to plan marketing according to product demand. Furthermore, as the case study company did not have an efficient system for the systematic collection and management of the database, the data relationship structures must be analyzed before a data storage system is developed. In this work, the online analytical processing (OLAP) system was used to analyze and retrieve information. Finally, the product life cycle and database management will be visualized through an intelligent dashboard.

The rest of this paper is organized as follows. Section 2 presents literature reviews. Section 3 explains the research methodology, including the development of a storage system and data relationship structures. Section 4 provides experimental results, followed by the discussion in Section 5. Finally, Section 6 provides the conclusions, limitations, and future research directions.

2. Literature Reviews

In today's competitive business environment, it is imperative for organizations to adapt to survive in response to internal and external rapid changes. As the world becomes more dynamic and collaborative, a good business strategy must be built in order to deliver actionable information and help guide executives, managers, and workers to plan and solve business problems in a timely manner [5]. The concepts of Business Intelligence and Industry 4.0 contribute to the sustainability and competitiveness of enterprises, improving sales and the effectiveness of decision-making in business operations.

2.1. Business Intelligence Systems and Applications

In recent decades, business intelligence systems have been adopted and utilized by a number of companies worldwide, as can be seen from a growing number of research studies in the field. BI has become an integral part of supporting business operations in many enterprises. It is the process of collecting, analyzing, and converting data into information or knowledge, which is then shown as reports or dashboards in a database to support business decision-making [6]. For instance, the work of [7] suggested that user satisfaction, cost reduction, and time efficiency are three factors to examine when implementing business intelligence. The results of this study showed that well-developed BI applications could increase the effectiveness of decision-making in business operations. In addition, qualitative surveys regarding BI have been carried out in [8] based on a semi-structured interview method. Twenty organizations in Poland that have used and made progress in business intelligence were interviewed. These represented sectors from telecommunications, consulting, banking, insurance, and marketing agencies. They came to the conclusion that BI may be a trigger for effective decision-making and improving business operations.

Database management and complex data analysis can be challenging for organizations with multiple functional contexts and dimensions. The work of [9] compared relational database systems (MySQL and MariaDB) with graph-based database systems (Neo4j) using different query types. Their results showed that the performance of databases depends upon the complexity of the data and query types. While graph database systems were more efficient for simple queries, relational model database systems became more efficient as the complexity of queries increased. The ontology is defined or scoped to specify the structure of a database. The work of [10] demonstrates that applications of ontology assist users in the decision-making process to determine and design a database management system that is most suitable for a specific situation or for specific data. The work of [11] found that the usage of Cloud Computing (CC) tended to increase because of the advantages of online storage, high scalability, and the ability to access information. The fact that CC can be undertaken anywhere with just an internet connection has greatly reduced operating costs and attracted many organizations to operationalize their businesses in the cloud. However, it is necessary to properly design data access and protection due to security and privacy. The work of [5] reviewed and analyzed 85 papers to classify and prioritize business intelligence concepts and approaches, which could be divided further into management, technique, and system-enabling approaches that facilitate BI. They found that in the beginning, the research focused more on the management approaches, and as research advances, technical approaches and enablement approaches would play a key role. It was also recommended that developers consider data in multiple dimensions to improve enterprise databases and decision support systems for business intelligence. The work of [12] considered a case study of a locally owned ride-sharing platform in Indonesia. Due to the rapid changes in technology, platform growth requires significant data and algorithm supervision to efficiently find the best match between customers and service providers. This research investigated the management of large databases and the performance of work assignments, performance, and a rating system that took into account the customer and service provider dimensions.

Three success factors for BI implementation were analyzed in [13]: organizational, process, and technology factors of BI. According to their findings, the organizational factor is the most important factor in determining the success of BI system implementation. The work of [14] focuses on the development of systems that can support the size and impact of problems related to corporate data. They also showed how organizations are adopting BI to support decision-making despite having to analyze a larger dataset. The work of [15] provides a practical framework for organizations to follow in order to achieve their business intelligence objectives of gaining an accurate and timely understanding of market conditions. The results of this research indicated that business intelligence systems enhance strategic decision-making credibility and have the potential to increase marketing

knowledge. However, it must be designed appropriately and in accordance with the organization's processes in order to increase efficiency and decision-making speed. Benefits of implementing business intelligence include, for example, improved data quality for decision-making, faster decision-making, and a more efficient work process. The work of [16] implements BI in the retail chain based on qualitative research methods. Several benefits of BI have been reported: receiving faster and more accurate reports, improving decision-making, improving customer service, and increasing revenue.

2.2. Business Intelligence Dashboards

A business intelligence dashboard is an interactive analysis tool that many businesses use to track, monitor, analyze, and display their business data and performance. The dashboard empowers the users to manipulate data and make better decisions by providing a comprehensive overview of the overall well-being of the business. The data are often displayed in the form of a visual report through pie graphs, line graphs, scatterplots, etc. The dashboard design should prioritize the flexibility of a variety of analytical perspectives to meet the user's needs [17]. Various business sectors in many countries are established examples already benefitting from business intelligence dashboards. Due to poor road safety policies, Thailand is one of the countries with the highest rate of road accident deaths. The goal of [18] is to explore the possibility of adopting a business intelligence system for data visualization and analysis in spatial and temporal dimensions in accident reports. The Talend Data Integration tool is used to collect data, after which the combined data is imported into a MySQL database, and the data visualization is created using Tableau software. The results of this study revealed that improvements in merging data, processing, and graphically displaying accident data to identify the cause of the accident improved data management. The system helps the department establish strategic choices and develop a suitable contingency plan to improve the accident scenario.

The dashboard trial in the emergency room was created in response to patient expectations for higher standards of care and to aid inpatient treatment by displaying flow status and critical patient information to improve symptom monitoring and facilitate patient care. A dashboard user satisfaction survey was conducted at the Royal Commission Hospital in Jubail, Saudi Arabia [19]. The questionnaire consisted of respondents' demographics, frequency of using dashboards, and satisfaction with dashboard use. The results of the research revealed that the application of dashboards to visualizations in emergency departments is frequently used with high satisfaction.

Due to continued population growth, a burgeoning industrial revolution, and an ever-increasing demand for energy, renewable energy has emerged as the world's fastest-growing energy source [20]. The purpose of this work is to evaluate the environmental and economic efficiency of renewable energy using data visualizations. Additionally, this article assesses the effectiveness, user engagement, and usability of two data visualization tools based on the dashboard and balanced scorecard. Case studies demonstrate that their developed tools are effective and useful for communication, as well as providing simplified guidelines for renewable energy development decision-making. BI was developed to help managers at XYZ Store [21] generate the necessary reports. The data are collected and visualized using a dashboard and graphic visualization. The output of this BI application is a sales dashboard and eleven graphic visualizations, as requested by the managers, to process information management for products, employees, and everyday transactions.

2.3. Business Intelligence and Principles of Marketing Mix in Automobile Industry

A few studies have reported on the use of business intelligence in the automobile industry. For example, the work of [22] studied the use of BI systems in the automotive industry and automotive companies. In order to gain access to data and analyze customer needs for effective product development decisions, they collected data by connecting various information related to the car, data sharing between all types of vehicles, and insights for designing and production. The work of [23] solved the problem of monthly sales

forecasting in the automotive industry in India with the principle of operations research using two forecasting methods, namely, moving average and exponential smoothing, as input for the Adaptive Neuro-Fuzzy Inference System. Their results show that effective sales forecasting can be used to support business systems.

The adoption of business intelligence in the area of the automotive parts industry (let alone the brake pads) is, however, still under-researched. In addition to our proposed research work, we found that a BI system was implemented in a multinational tire company [24] to analyze and design a mobile business intelligence system for productivity measurement and evaluation in the development of production lines.

Similar to any other consumable, brake pads need to be regularly replaced because they wear out as the vehicle is used over time. The product life cycle plays a key role in helping a management team determine and support strategic methods in advertising schedules, price points, expansion to new product markets, etc. A lifecycle marketing strategy is created as a guide for the company to enhance new product development capabilities [25]. Analyzing lifecycle marketing requires an understanding of the interrelationships of the organizational contexts, product lifecycle, and ecological marketing. The results of the analysis enable in-house managers to better plan and execute marketing strategy activities within organizational environments. In addition, as business providers have to compete with each other to survive in the industry, they should understand the needs and preferences of their customers as a strategy for maintaining long-term customers. The work by [26] studies the relationship between marketing mix, customer loyalty, and customer satisfaction in the hijab fashion industry. Having a good relationship with customers is key to maintaining competitiveness in the business system.

3. Methodology

In this study, we analyzed data using business analytic tools and presented information using business intelligence methodologies [27]. After collecting the data relating to external and internal factors affecting the case study company's sales, we developed a regression model to analyze the data and create a product life cycle, which was subsequently used to plan sales and visualized with business intelligence using Microsoft Power BI software. Figure 1 illustrates the business intelligence architecture.

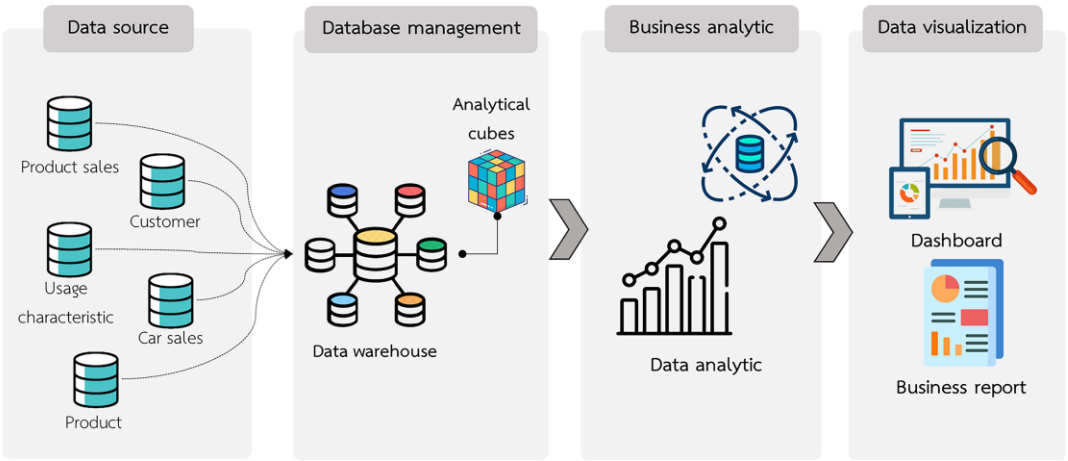

Figure 1. Business intelligence architecture.

3.1. Data Source

The research data were collected from a brake pad manufacturing company and the Department of Land Transport, Thailand. The company's products were divided into three types based on the vehicle characteristics that the product is compatible with, namely, large cars (Type A), small cars (Type B), and light trucks (Type C).

The data were divided into two categories: external and internal data.

The external data are the market information related to brake pad products that affect demand, including the cumulative number of vehicles, vehicle life expectancy, and vehicle mileage before brake replacement. The cumulative number of vehicles was calculated using vehicle sales statistics in Thailand, while the vehicle life expectancy and mileage of the vehicles were obtained from experts in the case study company as well as social media platforms that allow the general public to participate in sharing and exchanging opinions on the internet, such as Facebook and web boards, commonly known as a "Club or Community".

The internal data are those data from the case study company, as detailed in Table 1.

Table 1. Internal data from the case study company.

Attribute	Data Type	Details
Date	Date	Date of product sale
Product ID	Text	ID of product
Product name	Text	Name of product
Product sales	Whole number	Number of product sales
Part no.	Text	Spare part number
Car brand	Text	Name of car brand
Car model	Text	Name of car model
Segment	Text	Type of car
Type of usage	Text	Type of car usage
Car age	Whole number	Age of car
Car sales	Whole number	Number of product sales
Customer ID	Text	ID of customer
Customer name	Text	Name of customer
Sale team	Text	Name of sales team
Salesman ID	Text	ID of salesman
Salesman name	Text	Name of salesman
Province	Text	Province where products are sold
Region	Text	Region where products are sold

3.2. Database Management

The data collected from multiple sources undergo data cleansing, which is a data pre-processing step. Additionally, the data warehouse is designed to gather data from various sources, and online analytical processing (OLAP) techniques are used to identify and obtain data from the data warehouse.

3.2.1. Data Cleansing

Data cleansing is the process of examining data errors, inconsistencies, and redundancies to improve the quality of the data. The normalization approach, which is a method for reducing data duplication, where the data are formatted in the normal form, was used in this research to prepare the data before they can be imported into the data warehouse.

3.2.2. Data Warehouse

The data warehouse is the process of importing data from many sources into a centralized database [28]. In this research, the data warehouse is a step of collecting data from internal and external sources in a designated storage area. The data will be modified into a standard format and facilitates data analysis. This data warehouse is separated from the daily operating database. It will only be used to analyze and present the data. The OLAP data analysis system method was used in this research, which will be explained in more detail in the next section.

3.2.3. Online Analytical Processing (OLAP)

Online Analytical Processing is a system for analyzing and retrieving information. It is a tool used to analyze data in multidimensional models [29]. The user can view the data

according to the structure of factors (dimensions) and can also modify the view according to the needs of a system design method called the Snowflake Schema. The Snowflake Schema consists of a fact table (located in the middle) and dimensions, where dimensions are located around the fact table and have an attribute that links the fact table to the dimension of the data query so the users can modify the view. For example, the Customer ID in the fact table links to the customer dimension, and the Salesman ID in the customer dimension links to the salesman dimension. The Part no. in the fact table links to the car dimension, while the year in the car dimension links to the car-age dimension. The details of the structure are illustrated in Figure 2.

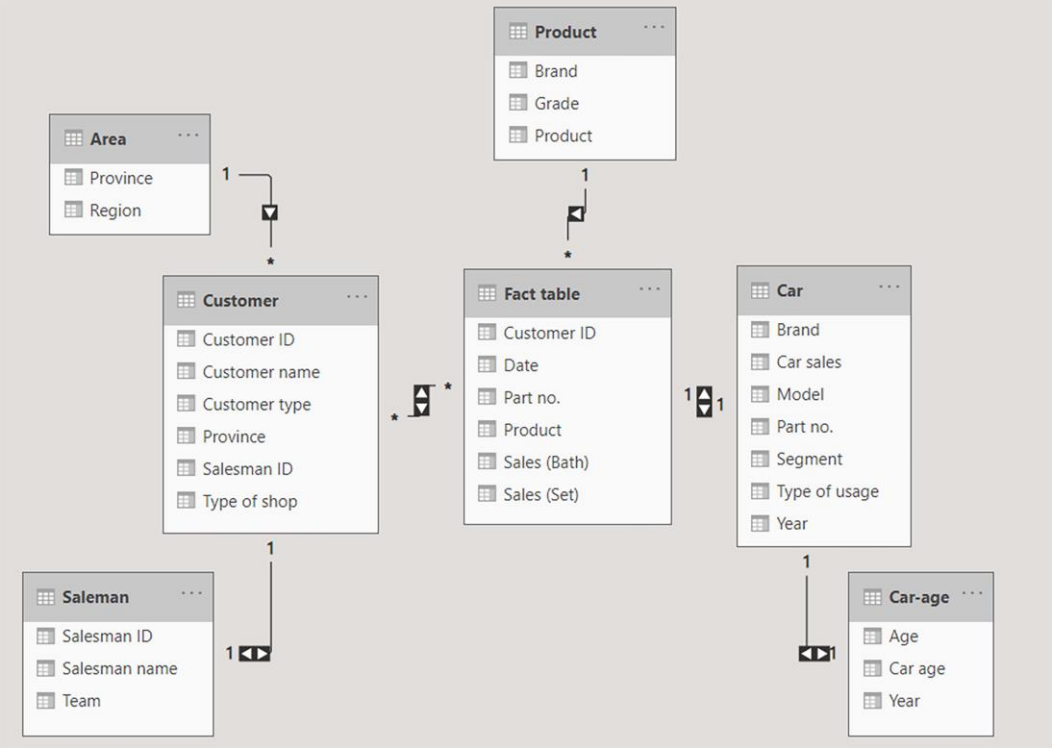

Figure 2. Snowflake schema structure. The notations (*:1) and (1:*) represent many-to-one and one-to-many relationships, respectively. The notation (1:1) indicates a one-to-one relationship.

3.3. Business Analytics

Data analysis makes the data usable for business support to forecast product sales. Because the replacement brake pads industry depends on the vehicle market, we created a life cycle to forecast the product sales volume.

As detailed in Figure 3, the product life cycle is divided into three stages according to the age of the vehicle [30]: (1) During the growth phase, the demand for replacement brake pads increases as the cumulative number of vehicles; (2) In the maturity phase, the demand for spare parts remains stagnant since the number of cumulative cars did not increase due to the discontinued cars; (3) The decline phase is the period when the demand for replacement parts decreases as the vehicle begins to disappear from the road due to the age or deterioration of the vehicle.

According to a report from the automotive industry, the factors that affect the demand for replacement parts include the number of cumulative vehicles, vehicle age, and vehicle mileage [4]. The annual demand for the brake pads (sets) can be estimated using the brake pads replacement cycle (depending on the mileage of a vehicle) and vehicle life expectancy;

$$\text{Demand} = N \times p \tag{1}$$

where N represents the number of vehicles on the roads, and p is the proportion of vehicles that require their brake pads replaced.

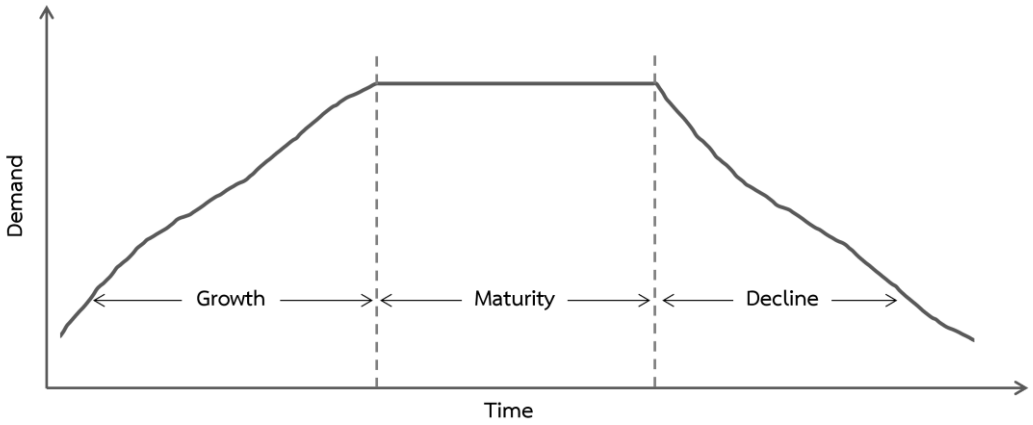

Figure 3. Stages of product life cycle.

According to the auto parts industry report [4], the demand for REM parts has an impact on product sales in the auto part industry. The report revealed that while the demand for OEM (original equipment manufacturer) parts decreased due to the drop in car production, the REM demand (including third-party brake pads, as in the case study company) would continue to grow following the cumulative number of the national vehicle fleet. Thus, we use a regression model to analyze the relationship between product demand and the sales of the case study company. In this regard, we assume that the company's product sales increase as a function of customer demand according to the industrial mechanism. Thus, the demand for brake pads will play the role of an independent variable (X), while the number of sales is a response variable (Y). The company's product sales data are the actual data collected from the company.

To handle data that may have non-normal distributions or a non-constant variance, we follow the following procedure to obtain the best-fit model.

Step 1: Transform the data using the Box–Cox transformation [31]. The method will transform the data in terms of the logarithm or exponentiation of variables: $Y \rightarrow \log(Y)$ or Y^{λ} and $X \rightarrow \log(X)$ or X^{β}, where λ, β are model parameters.

Step 2: The null hypothesis for regression:

H0: There is no relationship between response $\log(Y)$ or Y^{λ} and the independent variable $\log(X)$ or X^{β}.

Step 3: For each pair of λ, β, perform regression analysis.

Step 4: Among many possible pairs of λ, β (whose analysis reject H0), select the one that achieves the highest coefficient of determination (R-square)—as this coefficient determines how well the regression model predicts the response variable.

3.4. Data Visualization

The data from the data warehouse were gathered into Sections 3.1 and 3.2, and the results of the regression models from Section 3.3 are presented in the form of plots and tables. Power Query was used to refine the data by combining, extracting, adjusting, and pulling the data to display results in each report accordingly. The principle of selecting a display format must take into account the nature of the data, usage characteristics, and view of the display to make it easier for users to provide a report for supporting marketing decisions [32].

In this research, we output the data and results into four reports:

- Report 1: The car sales report displays Thailand's car sales data, which is external data reflecting the demand for the product.

- Report 2: The product sales report displays the company's product sales data, providing an overview report for tracking the sales and positioning of products in a market segment.
- Report 3: The sales forecast report is the product life cycle from relationship analysis through the regression model. The model is used to forecast sales and manage resources within the organization according to market demand.
- Report 4. The sales progress report provides product sales and sales representatives information by creating a unit price calculation and sales progress percentage to display the sales progress of the sales representatives to support sales targets and motivate sales representatives.

The report display format also considers the linking of the company's products and market needs to ensure a responsive marketing plan that meets the needs of customers. To this end, the principle of a marketing mixed design is used to analyze the design of the report display format to support planning and decision-making activities in marketing.

The 4Ps of the marketing mix include product, price, place, and promotion. The details of each of the 4Ps of the marketing mix used to design our display format are given in Figure 4.

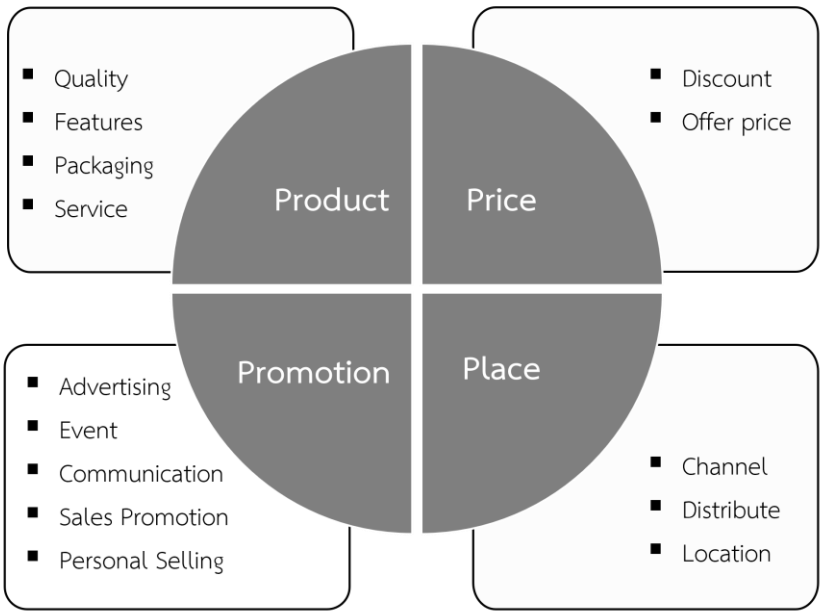

Figure 4. The marketing mix concept.

3.5. Summary of Research Methodology

We developed business intelligence by relying on both operations research and statistical analysis to investigate the relationship between product demand and product sales. The product life cycles were created to forecast product sales. The technology used in database management was applied to analyze and present the data through dashboards to support decisions for marketing planning. The dashboard design relies on the marketing mix principle, allowing users to track and analyze business performance. To be comprehensive, we summarize the research methodology in Sections 3.1–3.4 in Figure 5.

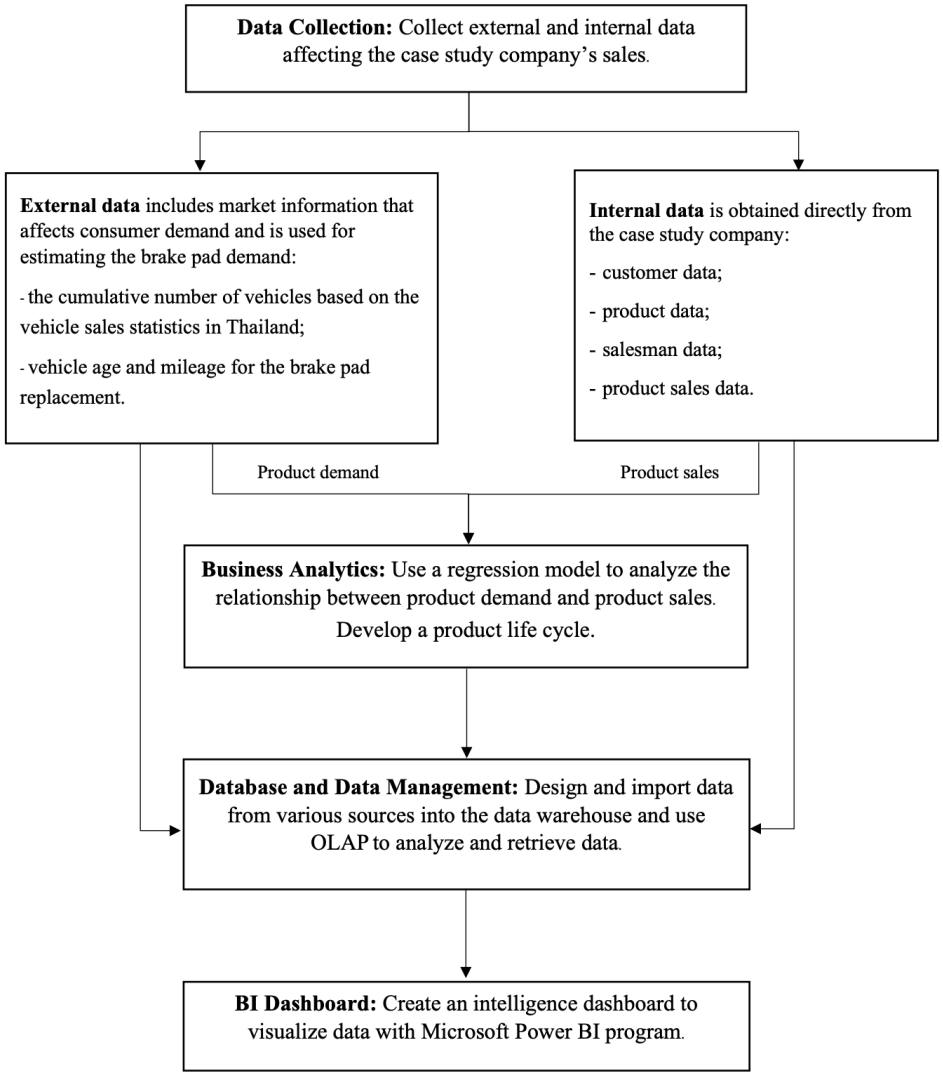

Figure 5. Research methodology flowchart.

4. Results

4.1. Business Analytics

The results of the Box–Cox regression models used to forecast product sales are discussed here. To check the model assumption, we first conducted a normality test with Anderson–Darling at a significance level of 0.05. We performed regression analysis for each Box–Cox model, which passed the normality test. Subsequently, the best model was selected using the R-square criterion. The Box–Cox regression model for each product type according to the selection criterion is shown in Table 2. Since customer demand can be estimated as a function of the cumulative vehicle number, which can further be used to predict the company sales demand, the actual linear regression equations are not provided here due to trade secrets.

Table 2. Best transformation models and the normality test.

	Type A (Large)	**Type B (Small)**	**Type C (Light Truck)**
Transformed equation	$X' = \ln(X)$ $Y' = Y^2$	$X' = \sqrt{X}$ $Y' = \ln(Y)$	$X' = \ln(X)$ $Y' = \ln(Y)$
p-value for normality test	0.438	0.108	0.203

The results of the regression analysis of the selected models are given in Table 3. Very small *p*-values indicate that the regression models are statistically significant, and the small standard errors of the regression imply the small average distance that the observed values fall from the regression line. Thus, overall, the models can statistically significantly predict the dependent variables. In addition, the high R-square values of 0.8 indicate that there is a strong correlation between product demand and sales. Therefore, the model is validated and can be used to forecast product sales and generate the product lifecycle for the BI system.

Table 3. The result of the linear regression models.

	Type A (Large)	Type B (Small)	Type C (Light Truck)
R-square	0.829	0.872	0.876
S.E.	0.117	3.54	0.132
p-value	0.000	0.000	0.000

4.2. Business Intelligence System

Data visualization was created for the marketing department. The design follows the company's workflow according to the details mentioned in Section 3.4 and the marketing mix principles, showing the consistency between market demand and the company's products. The conceptual framework of the display design that links the marketing mix with the data visualization of the company's workflow is shown in Figure 6. The blue textboxes are the data display. The yellow textboxes are operational guidelines or support marketing planning decisions based on the analysis of the displayed data. The arcs link the information display in the direction of the arrowhead to the operating guidelines.

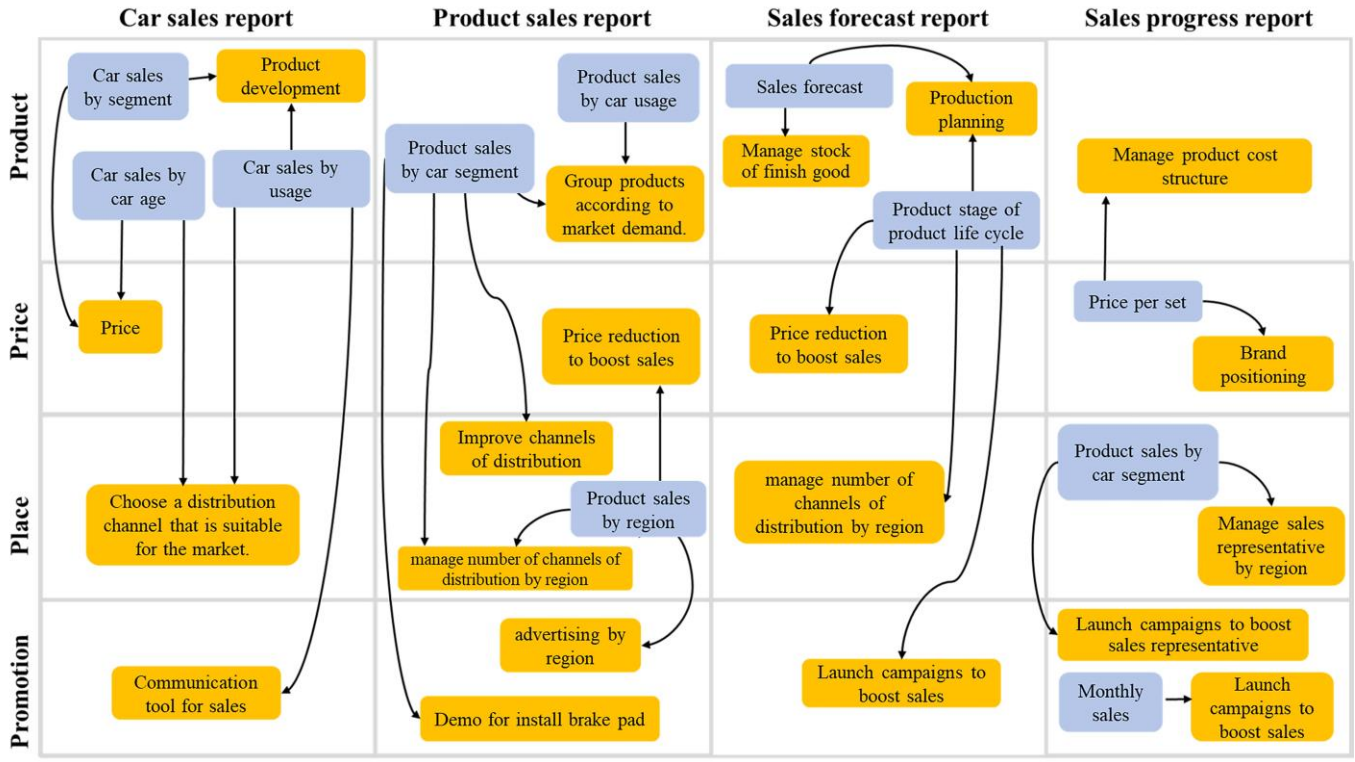

Figure 6. The framework of marketing mix strategy for intelligence.

4.3. Dashboard

One of our goals was to design reports to display databases in order to support marketing planning decisions in a way that users can easily access and adjust the perspective based

on their preferences. To support data filtering, we have created multiple and hierarchical filters to filter data in each report so that users can access data in detail according to their needs. As explained in Section 3.4, data visualization is divided into four reports, whose findings are now discussed in the following paragraphs:

Car sales reports reflect the demand for brake pads that are split into several categories of vehicle type, usage characteristics, and the age of the car. This information, in addition to the company's existing work process, can be used to increase competitiveness and the efficiency of product development, set sale prices, and select distribution channels.

Product sales reports provide an overview of the company's product sales. There are several product sales filtering options available, including product name, product model, region, and province. This report provides product sales data that can be used to track the company's sales outcomes in relation to product demand, sale pricing, channel distribution, and product promotion channels.

Sales forecast reports provide product sales projections derived from the product life cycles generated from the regression model to establish the relationship between product demand and product sales. There is an option to filter product sales data in the report. Forecasts of the company's product sales are included in the report to help with marketing planning decisions and the management of products and resources.

Sales progress reports provide data on sales and sales representatives. There are several product sales filtering options available, including product, product model, region, and province. In addition, the report also contains data relating to the sale price per set and sales progress, which provide insights into the product sales of a salesman in response to product demand, pricing structure, and product positioning.

An example of a car sales report generated with Microsoft Power BI software within the framework of a marketing mix strategy for business intelligence is illustrated in Figure 7.

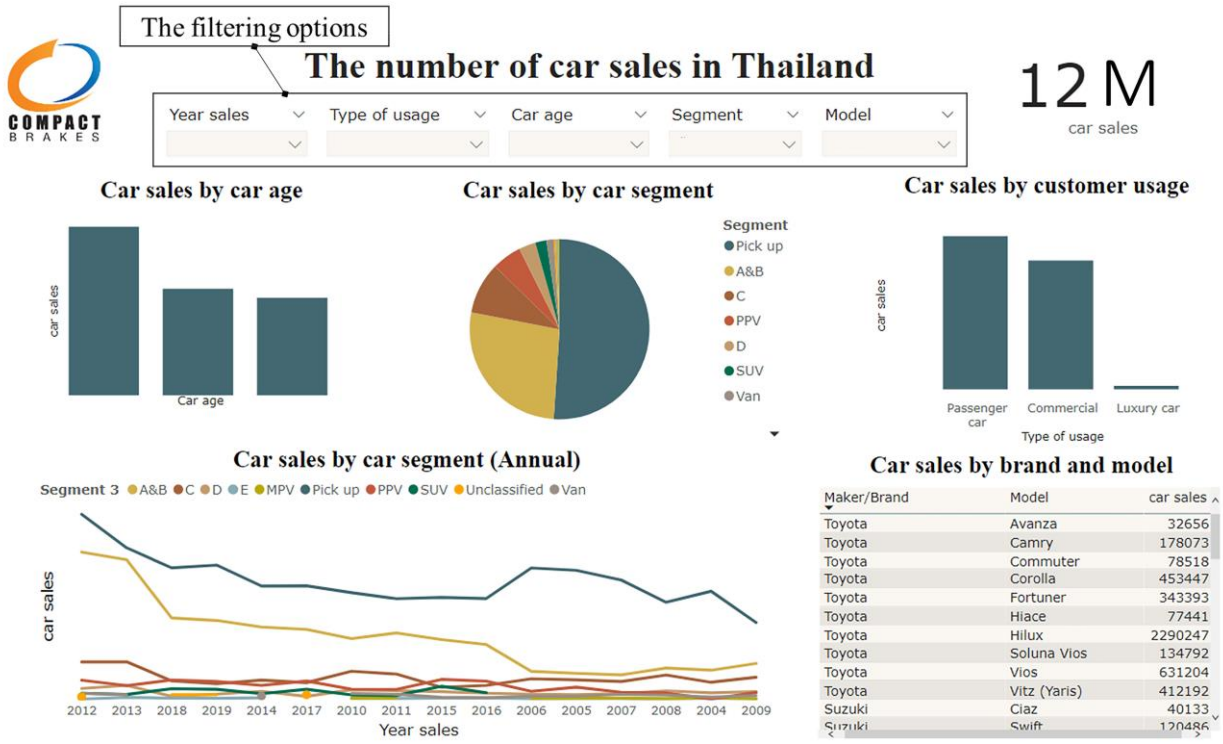

Figure 7. Example of a car sales report with business intelligence.

5. Discussion

During the business analytics process, we analyzed the relationship between the market demand and supply components of the company through the use of regression analysis, where the annual demand for the brake pads (sets) was estimated using the

product replacement cycle and vehicle life expectancy. The regression model for each product type is statistically significant and was used to generate the product lifecycle curve to forecast product sales. Subsequently, a business dashboard and the BI system were successfully implemented, and, therefore, the objective of this study was achieved.

Business intelligence systems have helped the case study company exploit technological innovations to achieve strategic advantages. The developed system increases workflow efficiency as it was able to simplify the traditional data preparation processes that required employees to collect and summarize data every time a request was made. Data has become much easier and more convenient to access using our cloud database as it is now accessible from many channels, such as mobile applications, web browsers, and desktop applications. Communication among employees is clearer and more effective, as the data can now be visualized through our intelligence dashboard. Strategic planners can conveniently use the dashboard to search for and display user-selected data. The dashboard presents results in appropriate formats and facilitates communication between employees effectively. Moreover, the dashboard can help support decision-making and increase work efficiency and productivity by reducing the time spent on recurring tasks.

In this work, we have demonstrated how BI systems could help us make better strategic decisions through the use of marketing mix and product life cycles. Likewise, a BI system has also been adopted, and it proved to be successful in a multinational tire company [24], which applied the key parameters of its production line to measure efficiency and mechanization. Furthermore, the balanced scorecard design principle has been used by the renewable energy industry [20] to evaluate environmental and financial performance. In the case of the XYZ store [21], they implemented sales transaction data management to generate reports to assist managers with data management for products, employees, and everyday transactions. These examples highlight the advantages of BI systems in supporting business decisions and making work processes much more efficient. In addition, other applications that already benefit from BI include hospital management [17,19] and road traffic accident management [18].

While many applications of BI systems have proven to be effective in guiding planners to make accurate and intelligent business decisions in the shortest possible time, it should be cautioned that when designing a dashboard for use in an organization with unique natures, it should be created in line with their business strategy to achieve the most out of the BI intelligence dashboard. In addition, it is not advisable to blindly copy the entire framework implemented in another company from A to Z just because it was successful in the first case. In particular, most of the data collected in this study (as in any other studies) were available in an improper format, some being corrupted. To arrive at a reliable conclusion, it is necessary to put some effort into validating, manipulating, transforming, and cleansing the data to ensure that the data introduced to the business intelligence system are accurate for use in data analytics and business cycle forecasting. In addition, since dashboards are a medium for communicating with users, it is advisable to have the users participate during the entire workflow of development and design. Otherwise, if the final dashboard is difficult to understand and unable to convey useful information, it can eventually result in BI failure.

6. Conclusions, Limitations and Future Work

In this research, business intelligence has been applied by analyzing the past and present data of a brake pad manufacturing company in Thailand. Through regression analysis, we found that product demand, estimated using the product replacement cycle and vehicle life expectancy, has a significant impact on the case study company's sales. A product lifecycle curve was subsequently created and used to forecast product sales. Moreover, a business intelligence dashboard, whose design relies on the marketing mix principle, was created, enabling planners to track and analyze business performance effectively.

While BI systems improve efficiency and help create a more productive company overall, there are, however, some limitations, which will now be addressed. Firstly, the

analysis in this study relies heavily on the data, be it internal (for data related to the case study company) or external (for the number of car sales in Thailand). Thus, bad data [33] (defined as those acquired through erroneous and/or sufficiently low-quality collection methods), as well as errors in long-term data storage and sharing, can degrade the research findings, and the research results might be invalid. Another limitation would be the simple regression we used in the quantification of the relationship between the (Box–Cox transformed) demand for brake pads and the (Box–Cox transformed) number of sales. As more than one independent variable can be correlated with the response variable, the model may be too simple for other instances. In addition, due to data availability, the developed marketing mix strategy framework relies only on domestic demand. Nevertheless, when data become available, it will be beneficial to also consider customer segmentation in the dashboard design to support effective marketing decisions.

The limitations mentioned above provide forward directions for future research. Once the data in the other stages of the life cycle become more available in the future, it is advisable to use historical data from the beginning to the end of the product's life cycle to study the behavior of the actual product life cycle at each stage. In addition, multiple linear regression might be more suitable as it can also capture potential confounding factors in the studies. If it is more complex, it is likely that the model will better predict the response variables, increasing the effectiveness of a product life cycle used for marketing planning. Last but not least, the applications of business intelligence and business analytics are expected to expand and cover all of the company's product lines. This will help the management team establish effective decision-making strategies, which is one of the most important indicators for demonstrating that an organization is moving toward a sustainable business model.

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