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APPLICATION OF POWER BI FOR ENHANCING DATA-DRIVEN RETAIL BUSINESS MANAGEMENT

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ABSTRACT: *In the competitive retail industry, the ability to analyze and visualize revenue and profit data is crucial for decision-making and improving operational efficiency. This paper examines the application of Microsoft Power BI to visualize revenue and profit metrics within retail systems. To facilitate data organization and utilization, the study proposes a data structure for storing retail system data. Using stored data, Microsoft Power BI connects to the database, aggregates information, and generates interactive visual reports in the form of charts, enabling managers to easily observe business performance metrics. The paper collects data from the CHA retail system and then implements the visualization of this real-world data. It highlights the potential of Power BI as a powerful tool, offering a practical framework for organizations seeking to leverage data to enhance decision-making processes.*
KEYWORDS: *Microsoft Power BI, Retail Data Visualization, Revenue and Profit Analysis, Business Intelligence Tools, Data-Driven Decision Making*

INTRODUCTION

Data organization in retail is an important aspect in helping retailers grasp and predict customer needs. Analyzing customer data in the retail industry can help retailers develop strategies for product and service development. Data analysis is becoming an important factor in business operations. In retail business, data on sales and business operations continuously creates a large data source. This data source can be considered an extremely important information asset that helps businesses synthesize, analyze, monitor, and improve management capabilities to gain a competitive advantage in today's rapidly changing business environment. To effectively exploit this data source, businesses need to promote digital transformation, deploy integrated processing procedures with consistent data organization methods, data synthesis and visualization methods to help managers easily monitor, supervise and make correct and timely business decisions. Data visualization plays an important role in converting complex digital information and data into easy-to-understand images and charts. This helps us quickly grasp information, see patterns and trends, and interact directly with data.

Organizing and effectively exploiting large data warehouses is increasingly important for retail businesses. To solve this problem, businesses need to improve their digital transformation capabilities [2], apply intelligent analysis technologies [3] to their businesses to increase competitiveness, improve productivity and work efficiency. In the article [4], the authors pointed out the role of digital transformation in businesses in Vietnam, in which the factor of deploying information technology applications in businesses is very important, affecting the effectiveness of business management and operations. Microsoft Power BI [1] is one of the most popular and optimal tools for businesses. With its powerful and easy-to-use capabilities, Power BI allows users to connect, transform, and visualize data from multiple sources.

Previous research has focused on studying different aspects of the retail industry. Some studies have used linear regression analysis to conduct sales and profit forecasting over time. Shivankar et al. [1] tested a model built using Xgboost and linear regression techniques on the Big Mart dataset and demonstrated that their technique produced more accurate predictions than other existing techniques. Research [2] used multiple linear regression in Python and visualization through power BI, the predictive analysis results can support potential customers and boost sales to a higher level. Yeramarus Muralidhar [3] used Power BI combined with retail analytics data using DAX queries, this project represented large datasets into visualizations to see sales performance in the fastest way. Silva [4]'s study combined two OLAP cubes into a single Data Mark using DAX programming, the results showed that end users accepted the reports because they could have better and more frequent control over their data. In [5], the author developed a datamark, supporting the construction of OLAP cubes to build charts according to indicators, resulting in dynamic dashboards that optimized the decision-making mechanism in the sales and administrative areas, shaping the improvement of goals based on indicators. Edhya [6] used Kimball's 4-step data warehouse modeling method and ETL to mine data, design the data warehouse structure according to requirements. In addition, Reis [7] also used the ETL system and MS Power BI applied to sales data, as a result, it solved the existing problems that old reports encountered, improving the reporting system. Moyano et al. [8] deployed Power BI to forecast customer preferences, so that businesses can make immediate business decisions, resulting in creating a data mart to help grasp the customer situation, the actual business situation. Research number [9] applied a star data model to

describe and predict the demand for GranSol cooperative products, as a result, it helped the cooperative to distribute products to branches, forecast products and improve competitiveness in the market; estimate future sales.

RESEARCH METHODS AND APPLIED TECHNOLOGIES

Microsoft Power BI (MSPB) is a business analytics service provided by Microsoft that aims to provide interactive visualization and business intelligence capabilities to create reports and dashboards for end users. It has the ability to collect complete data from various data sources, organize and visualize the data, and then quickly share the results with users. Power BI [11] integrates the cloud, providing data warehouse capabilities such as data preparation, data exploration, and interactive dashboards. Power BI also has the ability to combine different databases, files, and web services to quickly change or correct data errors and incidents, connect to SQL Server, allowing users to integrate all data in the company whether in the cloud or on-premises, update and adjust data accurately. This application first appeared in July 2011 and was originally called Project Cresce along with SQL Server and codenamed Denali. And in September 2013, this tool was officially renamed Power BI. In the beginning, it was built on Excel with features such as Power Query, Power Pivot and Power View. However, the upgraded point here is the ability to connect data and high security. In July 2015, Power BI was officially launched as a standalone product.

II.1. Main functions of Power BI

Power BI is a business analytics toolkit developed by Microsoft, it provides a comprehensive solution to connect, transform, model, visualize and share data. PowerBI provides many functions, bringing maximum convenience to users, below are some of the main functions of PowerBI.

Table 1. Main functions of Power BI

Function	Description	Note
Data Connectivity	Power BI supports connecting more than 200 diverse data sources, making it easy to query and manage data. Connect to relational, non-relational databases, cloud services, data files and online data.	SQL Server, Oracle, MySQL Excel, CSV, Odata,…
Data Transformation	PowerBI provides many powerful tools for manipulating and cleaning data such as removing error data, converting data to suitable data types, cleaning data, etc.	Use DAX statements to process data such as mround, sum, count, values, district,…
Data Modeling	There are 2 methods to model data in PowerBIUse data cubes to store data in a multidimensional structure	
Data Visualization	Use tables and relationships to describe data structures, suitable for large and complex data sets	Line, column, pie charts; heatmap, scatter, Gantt, funnel,…
Share Reports	PowerBI provides many types of charts and visual graphs to represent data in many different ways, vividly and easily understood. In addition, it also supports advanced tools such as Power BI Q&A and Power BI Themes	Format PDF, PNG,

II.2. Working Method of Microsoft Power BI

Power BI works on a few core principles and its strengths address some of the common challenges of working with data and analytics. Figure 1 is the basic workflow of PowerBI.

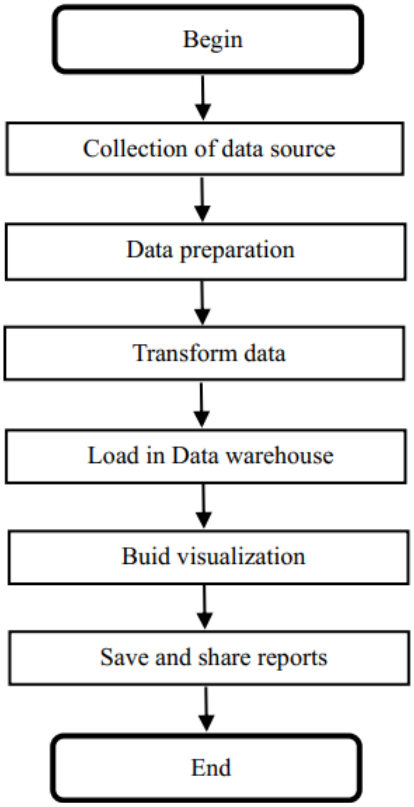

Fig 1. Power BI activity diagram

- Data Sources: Power BI extracts data from various servers, Excel sheets, CSV files, and databases. The extracted information can be imported directly into Power BI or a direct service link can be set up to receive that information. If you import data directly into Power BI, it will only be compressed up to 1 GB.

- Data Transformation: Before visualizing the data, it is recommended to clean and pre-process the data. This means removing useless or missing values from rows or columns. Then, certain rules are applied to transform and load the datasets into the warehouse.

- Reporting and Publishing: After cleaning and transforming the data, reports are generated based on the requirements. Reports are visualizations of data with various filters and constraints presented in the form of graphs, pie charts, and other figures.

- Create dashboards: Power BI dashboards are created by pinning individual elements or pages of a live report. Dashboards are created after you have published your report to the BI service. When reports are saved, the visuals retain the selected filter settings so users can apply filters and slicers.

Bên cạnh đó PowerBI có thể tích hợp vào các ứng dụng khác:

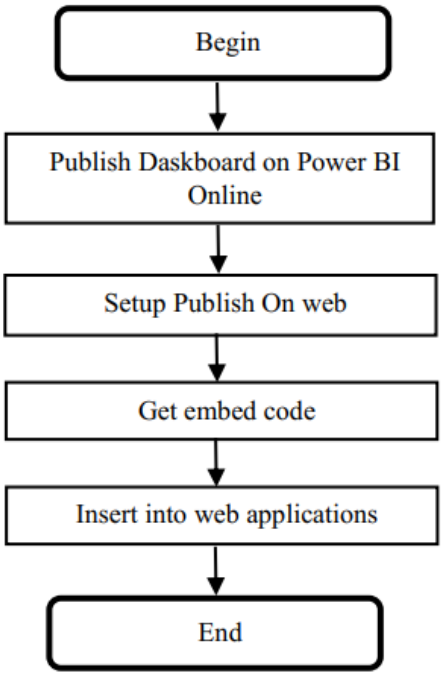

Fig 2. Power BI intergration diagram with other applications

Integrating MSPB into other applications offers many practical benefits. Users can directly access the data and insights they need to make decisions right within the application they are using, saving time and effort. Having data in a central location also promotes productivity and teamwork, contributing to improved decision-making within the enterprise.

II.3. Advantages of MSPB application in enterprise

Power BI is not only a powerful tool for visualizing and analyzing business data, but also a source of important data from many different sources, including data generated during production or daily business operations. Through the use of Power BI, businesses can enhance their ability to manage and monitor their specific activities, thereby helping managers and leaders make more accurate decisions. Using Power BI in business brings many significant benefits. First of all, Power BI allows organizations to synthesize and visualize data from many different sources easily and effectively. This helps businesses better understand their business operations through analyzing and modeling data into vivid charts, tables and maps. Second, Power BI provides flexible integration with many different data sources, from internal databases to cloud services and web data sources. This gives organizations a more comprehensive view of business data and the ability to develop diverse reports and analyses based on information collected from multiple sources.

Next, Power BI provides automation and scheduling features, helping organizations save time and effort in updating and managing data. This helps managers spend more time on analysis and making more accurate decisions. In particular, Power BI's security features allow departments within the organization to track and manage data in a separate way, helping to avoid data being disclosed to the outside or conflicts of interest. This ensures security and transparency in business data management. Finally, Power BI is designed with a friendly and easy-to-use interface, helping users from technical staff to business users to access and utilize its features effectively. This facilitates easy dissemination and adoption of the tool across the organization.

DATA COLLECTION AND VISUALIZATION

In this research, the team surveyed and collected a data set on revenue, profit, and goods of a CHA branch store in 2022 to analyze and use for research purposes to apply Power BI to the retail system.

III.1. Data structure for storing retail system data

The data structure in a retail system is typically designed using a relational database model or a data warehouse model. Data is organized into tables representing key entities such as products, customers, suppliers, sales transactions, inventory, and promotion details. These tables are interconnected through primary and foreign keys to ensure data integrity. Additionally, historical data tables, such as sales reports and shopping trends over time, are stored to support analysis and

forecasting. To optimize performance, data is often organized using the Star Schema or Snowflake Schema models, combined with advanced query techniques like DAX in Power BI to enable effective data visualization and analysis. Table 2 presents main database entities to store retail data.

Table 2. Description of tables in the database

No.	Table name	Description
1	tblNhomKhachHang	Includes customer group information
2	tblKhachHangNhaCungCap	Store detailed information about customers, suppliers
3	tblKhuVuc	Information about customer areas, suppliers, store locations and employees
4	tblThuChi	Includes all detailed information about the store's income and expenditure
5	tblNoiDungThuChi	Record the store's income and expenditure. What is the income/expenditure for
6	tblNhanVien	Detailed information about the store's employees
7	tblHinhThucThanhToan	Includes 2 forms: cash or transfer
8	tblDonViQuyDoi	Record the original unit, the converted unit, the converted quantity of that product
9	tblNhomHangHoa	Includes information about the product group
10	tblNganhHang	Wider than the product group, record information about the product industry
11	tblHangHoa	Store product information
12	tblDanhSachCuaHang	Record information about the current store list
13	tblKhoHang	Store information about which warehouse the goods are stored in
14	tblNhapXuat	Includes information about the store's import and export activities according to invoice amount

III.2. ETL Data Processing in PowerBI

Power Query in Power BI is an extremely powerful data preprocessing (ETL) tool that allows users to mine, transform, and load data from various sources into Power BI for analysis and visualization. It simplifies the data preparation process, from data cleaning, aggregation, to complex data transformations, without writing complex code. This makes Power Query an indispensable tool for data analysts using Power BI.

Power Query works on the principles of data query and data transformation. Starting with connecting to a data source, Power Query supports connecting to multiple data sources such as Excel, CSV, SQL Server, Oracle, SharePoint, web API, ...

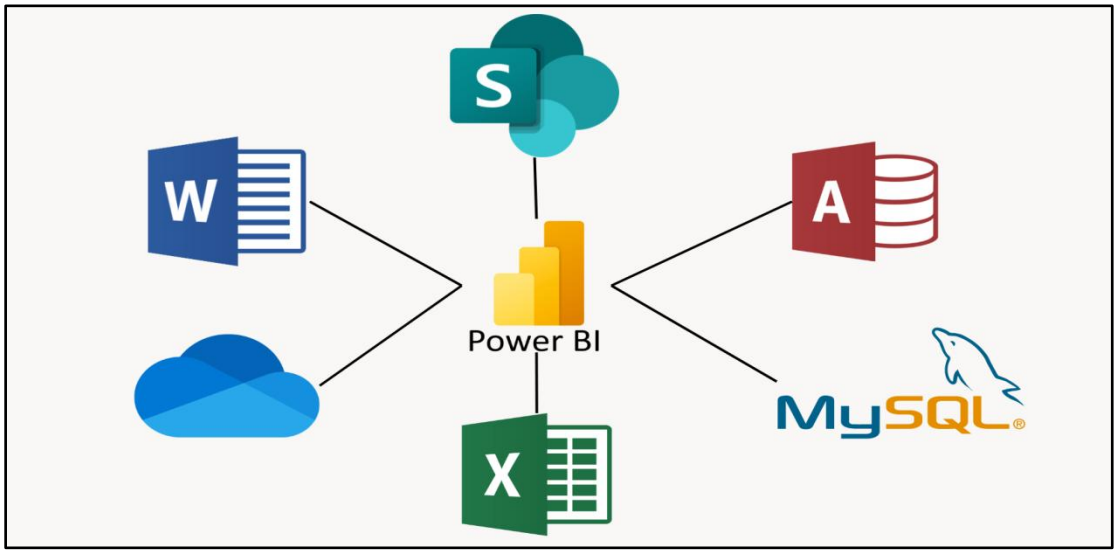

Fig 3. Connecting multiple data sources in Power BI

Once you connect to the data, Power Query provides an intuitive interface for manipulating and transforming the data. Common operations include filtering, sorting, grouping, aggregating, changing data types, removing null values, and more. Power Query also supports advanced features like creating new columns, combining data from multiple sources, and more.

III.3. Data of retail systems

CHA Store Sales Data 2022 is an important source of information to help the team complete the research paper. This data includes numbers and information related to the revenue and profit that CHA stores earned from the sale of products or services during the period from January to December 2022.

Table 3. CHA revenue dataset in 2022

Name	Month	Year	Revenue	%/year
RV.01.22	1	2022	11,946,385,276	9.15
RV.02.22	2	2022	7,008,843,219	5.37
RV.03.22	3	2022	8,399,197,167	6.44
RV.04.22	4	2022	7,709,974,898	5.91
RV.05.22	5	2022	7,958,309,811	6.10
RV.06.22	6	2022	7,024,551,307	5.38
RV.07.22	7	2022	9,048,200,252	6.93
RV.08.22	8	2022	11,129,417,672	8.53
RV.09.22	9	2022	11,698,859,021	8.97
RV.10.22	10	2022	12,804,057,253	9.81
RV.11.22	11	2022	15,804,231,316	12.11
RV.12.22	12	2022	19,961,895,533	15.30
Total:			130,493,922,726	100.00

Table 4. CHA profit dataset in 2022 2022

Name	Month	Year	Profit	%/year
PR.01.22	1	2022	908,244,516	7.88
PR.02.22	2	2022	647,397,569	5.61
PR.03.22	3	2022	680,169,674	5.9
PR.04.22	4	2022	711,341,568	6.17
PR.05.22	5	2022	607,459,879	5.27
PR.06.22	6	2022	579,181,428	5.02
PR.07.22	7	2022	803,673,110	6.97
PR.08.22	8	2022	998,767,447	8.66
PR.09.22	9	2022	978,585,194	8.49
PR .10.22	10	2022	1,222,163,398	10.6
PR.11.22	11	2022	1,459,172,880	12.65
PR.12.22	12	2022	1,936,661,083	16.79
Total:			11,532,817,746	100.00

III.4.Data visualization

Visualizing data from the retail system data structure transforms complex information into easily understandable charts and reports, supporting analysis and decision-making. Data from tables such as sales transactions, products, customers, and inventory is queried and aggregated to generate visual representations like bar charts, pie charts, timelines, or heat maps. Tools like Microsoft Power BI leverage the DAX query language to combine and analyze data, creating dashboards that display shopping trends, business performance, inventory forecasts, and promotional program effectiveness. These visualizations enable managers to easily identify opportunities, challenges, and make accurate, timely business decisions.

In the dashboard, the overview report displays information about CHA Company (figure 4), which managers can use to monitor the sales performance of agents from many different perspectives such as revenue, profit, number of customers and information about goods and employees. In the dashboard, each detail of the dashboard is displayed in the

most intuitive form of a report, thereby helping managers to easily manage. The image below is an overview of the reporting results that our team has performed on the data set provided by CHA Company.

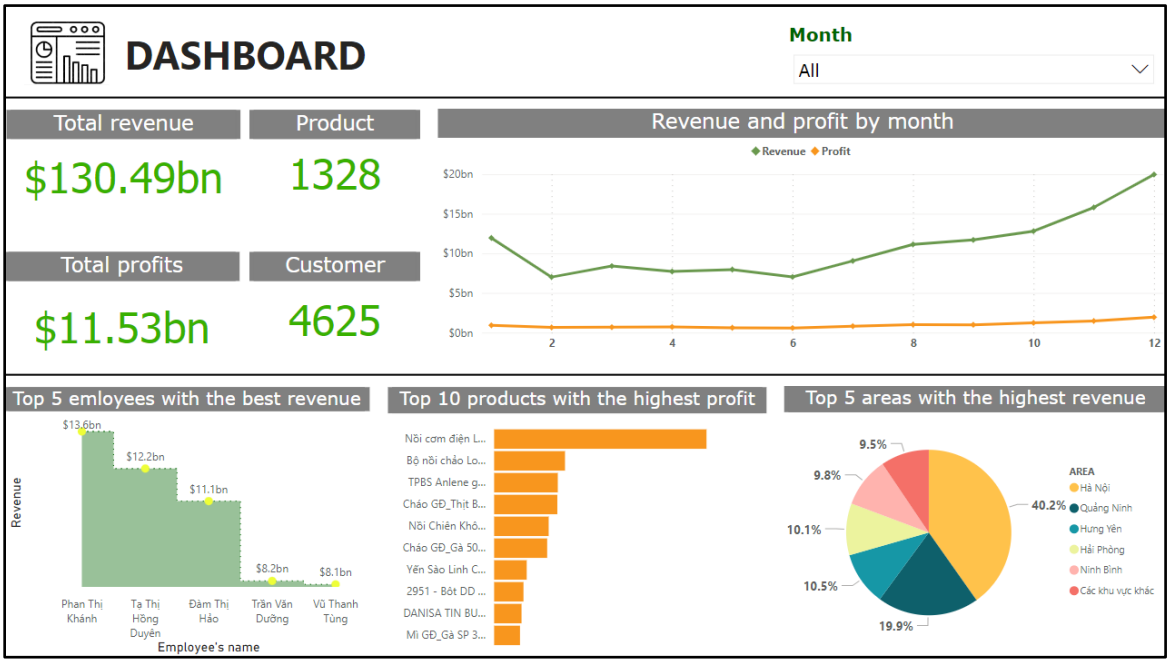

Fig4. Power BI Dashboard Overview

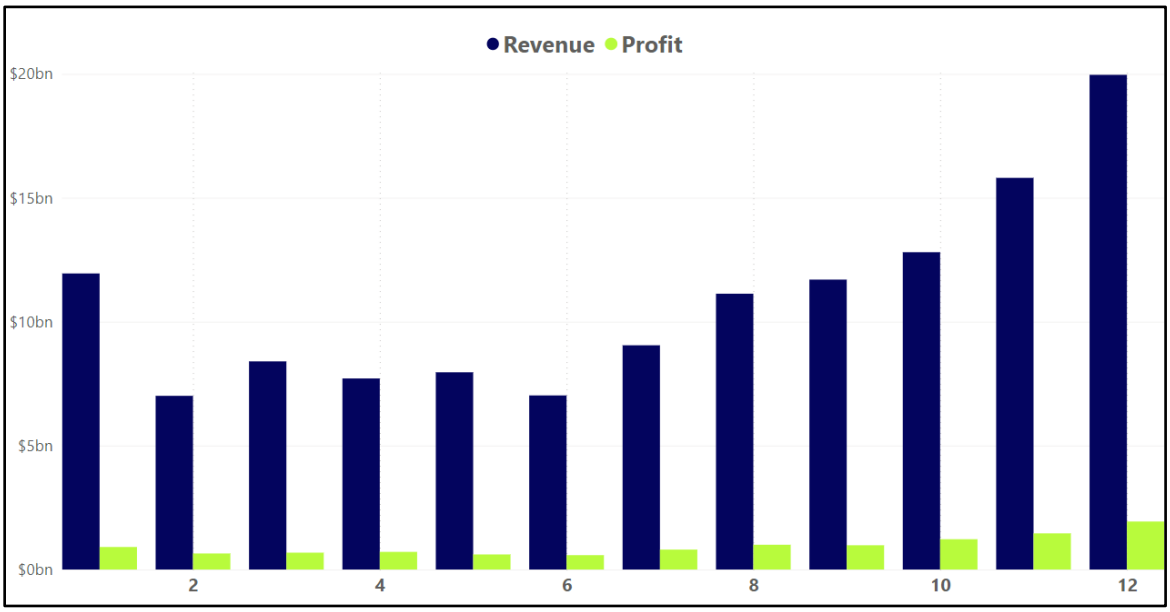

Fig 5. Revenue and profit by month

The chart shows a company's revenue and profit for 12 months in a line chart. Revenue tends to decrease from January to June and then increase from July to December. Revenue and profit are correlated, when revenue increases, profit also increases and vice versa.

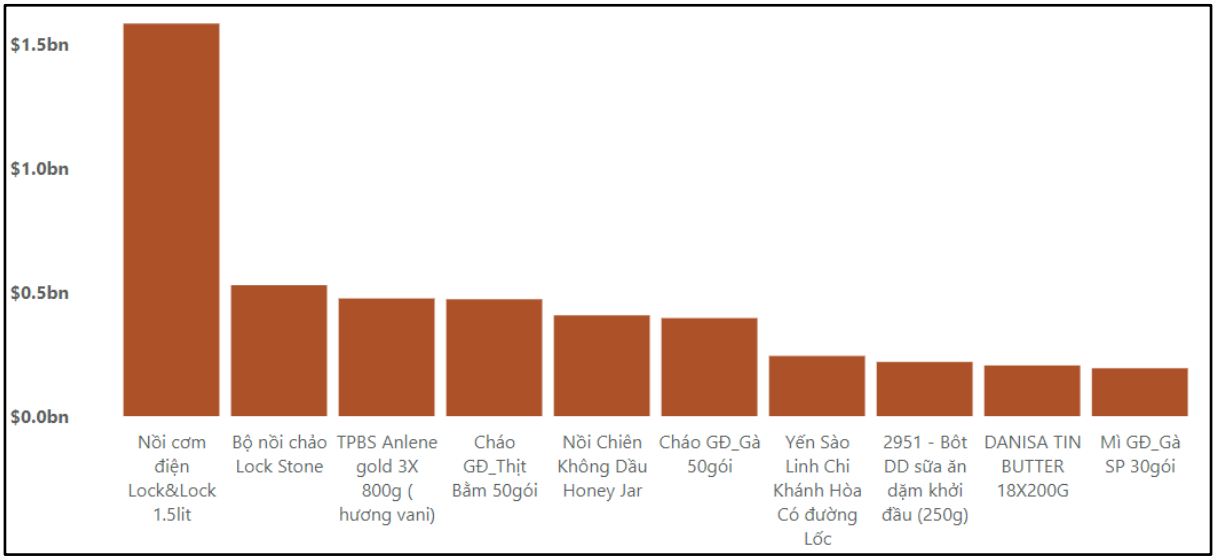

Fig6. Top 10 best selling products

For the data displaying the Top best-selling products, the research team uses a column chart (Figure 6), this chart can easily compare, evaluate the overview, and rank the products. In the research article, with the dashboard displaying the Top best-selling products, we can easily see the best-selling item Lock & Lock 1.5-liter rice cooker. Moreover, when they want to see details about the quantity of each item, they can click on each box to view the information.

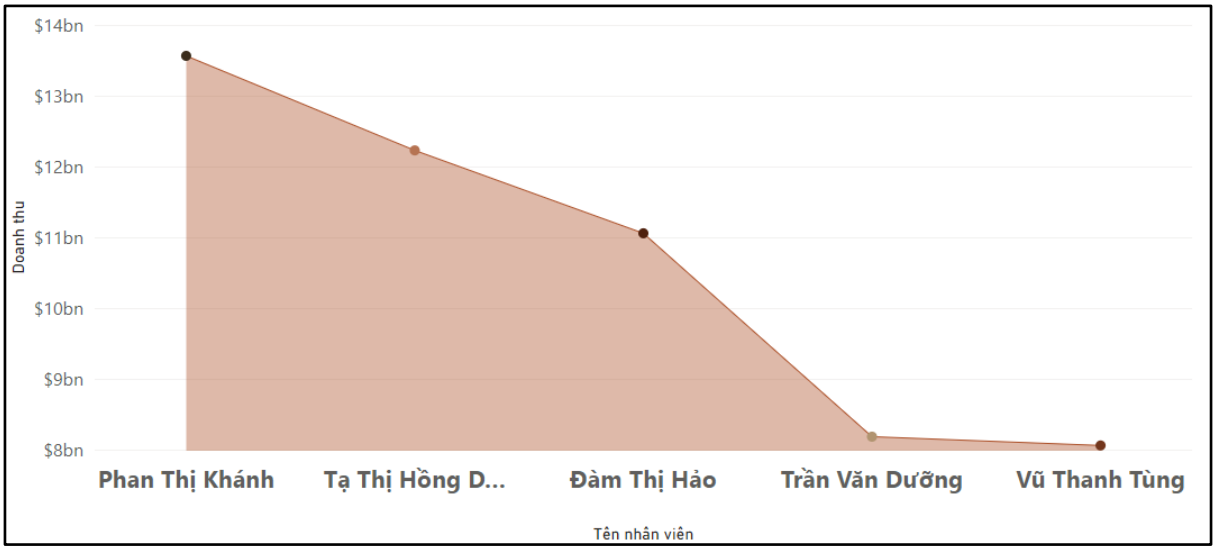

Fig7. Top 5 employees with the best revenue

The Figure 7 shows the revenue of the 5 employees with the best revenue in 2022 of CHA Company. Their revenue ranges from 8 to 13 billion VND, with Phan Thi Khanh achieving the highest revenue of 13 billion VND and Vu Thanh Tung achieving the lowest revenue of 8 billion VND. The chart shows the difference in work efficiency between employees, and also shows their potential for future development.

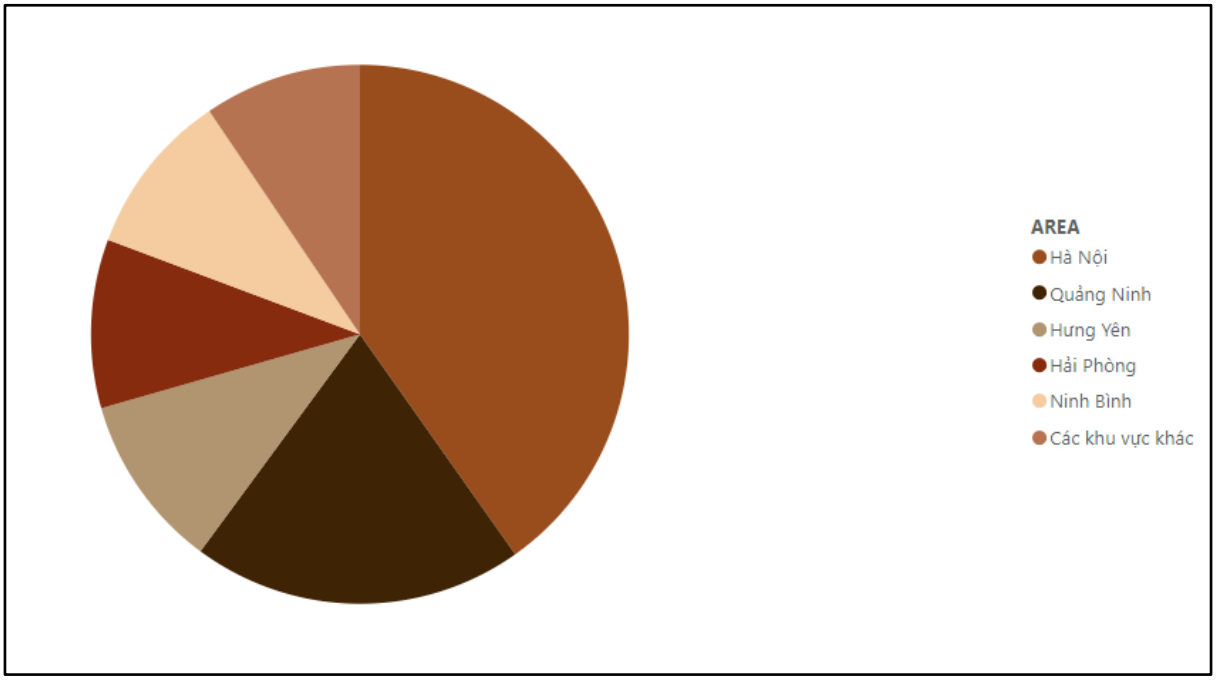

Fig8. Top 5 most profitable areas

The pie chart (Figure 8) shows the Top 5 regions with the highest profits, with Hanoi leading with 40%, followed by Quang Ninh 20%, Hung Yen 11%, Hai Phong 10% and Ninh Binh 9%. The remaining regions account for 10%. The chart shows a large difference in profits between regions, with Hanoi and Quang Ninh contributing up to 60% of total profits.

CONCLUSION

The research demonstrates the application of data analysis and visualization tools in intelligent data analysis to enhance enterprise management capabilities. This approach aims to drive increased revenue, profitability, competitiveness, and operational efficiency. Additionally, the article introduces a standardized and unified data structure for organizing retail data storage and proposes calculation formulas for data aggregation. Real-world retail data, including CHA data from 2022, is utilized to generate visual reports using Microsoft Power BI. This visualization enables managers to monitor business performance effectively and make timely decisions based on actionable insights.

However, the dataset used in this study primarily focuses on direct retail, overlooking the increasingly prominent online sales segment. Key features such as order delivery tracking, comprehensive inventory management, debt monitoring, and KPI visualization are not fully represented in the dashboard. Future research could expand by integrating data from multiple platforms, offering a more holistic perspective of the retail industry and addressing its diverse operational aspects.

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