NOVA IMS Information Management School

# MGI

Master's Degree Program in
**Information Management**

## Enhancing Staffing Efficiency in Restaurants with a Real-time BI Dashboard

Development of a BI Dashboard for Redmond Farm Kitchen

Phillip Hinson

Master's Thesis

presented as partial requirement for obtaining the Master's Degree in Information Management

**NOVA Information Management School**
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# ENHANCING STAFFING EFFICIENCY IN RESTAURANTS WITH A REAL-TIME BI DASHBOARD

**Development of a BI Dashboard for Redmond Farm Kitchen**

by

Phillip Hinson

Master Thesis presented as partial requirement for obtaining a Master's degree in Information Management, with a specialization in Knowledge Management and Business Intelligence.

## Supervised by

Professor Bruno Jardim, PhD, NOVA Information Management School

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# STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledged the Rules of Conduct and Code of Honor from the NOVA Information Management School.

*[Lisbon, July 2024]*

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# ABSTRACT

The restaurant industry faces a significant challenge in effectively utilizing Business Intelligence (BI) systems due to their complexity and the cognitive burden they place on users. This thesis addresses this issue by developing a user-friendly, real-time BI dashboard tailored to the operational needs of Redmond Farm Kitchen, an establishment with diverse operations including dairy production, cafes, and retail outlets. Located in Utah, U.S.A., Redmond Farm Kitchen provides an ideal environment to test the dashboard's impact on staffing efficiency and operational cost management. The primary objective is to bridge the gap between the theoretical capabilities of BI tools and their real-world application. The methodology combines theoretical BI principles of the Kimball Life Cycle with practical development and testing within the operational environment of Redmond Farm Kitchen. This approach ensures that the dashboard is grounded in sound decision theory and refined through actual business application. The real-time BI dashboard integrates data from the point-of-sale system, enabling dynamic management of staffing and resources based on real-time insights. By addressing the complexity and cognitive load issues, the project demonstrates the potential for real-time BI tools to transform operational decision-making in the restaurant industry. This work contributes to the broader industry by providing a practical solution that enhances operational efficiency and cost management, showcasing the transformative power of accessible and actionable BI systems.



# KEYWORDS

Business Intelligence (BI); Real-Time Analytics; Staffing Efficiency; Operational Cost Management; Restaurant Industry


## Sustainable Development Goals (SDG):

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| | |
|---|---|
| **AI** | Artificial Intelligence, which involves the simulation of human intelligence in machines that are programmed to think and learn like humans. |
| **API** | Application Programming Interface, a set of rules and tools for building software applications, allowing different programs to communicate with each other. |
| **BI** | Business Intelligence systems that support data analysis and decision-making processes, enhancing operational efficiency and strategic planning. |
| **BIT** | Business Intelligence Tools, which are applications and technologies used to gather, provide access to, and analyze data and information about company operations. |
| **CR** | Cloud Retailer POS |
| **DSS** | Decision Support Systems, which are computer-based information systems that support business or organizational decision-making activities. |
| **ETL** | Extract, Transform, Load processes used in data warehousing to extract data from different sources, transform it into a suitable format, and load it into a data warehouse. |
| **KPI** | Key Performance Indicators, which are measurable values used to evaluate the success of an organization or of a particular activity in which it engages. |
| **MBKM** | Mini-Batch K-Means, a clustering algorithm used in machine learning to partition data into clusters, or groups, with similar characteristics. |
| **MBA** | Market Basket Analysis, a data mining technique used to uncover purchase patterns and associations between different items. |
| **POS** | Point of Sale systems that handle transactions, including sales, returns, and exchanges, and provide critical data for business analysis. |
| **TPM** | Transactional Processing Management, which refers to the management of data transactions to ensure accuracy and reliability in processing systems. |
| **XGBoost** | Extreme Gradient Boosting, a machine learning algorithm that is used for supervised learning problems, to predict a target variable based on a set of input features. |

# 1. Introduction

## 1.1. Motivation

This master's thesis addresses a critical disconnect in the restaurant industry: the abundant availability of Business Intelligence (BI) systems and their surprisingly limited application in practical settings. The project is inspired by the significant potential that real-time BI dashboards hold for improving staffing efficiency and operational cost management. A potential that is often nullified by the complexity of these systems and the cognitive burden they place on users.

The focus of this work is the development of a user-friendly, real-time BI dashboard, specifically tailored to the operational context of Redmond Farm Kitchen. This establishment, with its diverse and dynamic business model, provides the practical environment to assess the dashboard's functionality and impact on labor cost efficiencies.

## 1.2. Redmond Farm Kitchen

Redmond Farm Kitchen’s operations encompass dairy production, cafes, and retail outlets, presenting an ideal model for understanding the complexities of staffing in a dynamic food service and retail environment. The farm, located in Redmond, Utah, U.S.A., is renowned for its commitment to ethical, sustainable farming practices and the production of high-quality, nutrient-dense foods. It operates a series of stores and cafes (Redmond Heritage Farm Store and Redmond Farm Kitchen), a production kitchen, a milk truck for distribution, and two farms (Redmond Heritage Farm and Rivendell Farm). These components function together to form a network of operations that require efficient staff management, particularly in the restaurant department.

## 1.3. Objectives and Methodology

Recognizing the gap between the theoretical capabilities of BI tools and their real-world usage, this project aims to design a dashboard that effectively communicates actionable insights without overwhelming its users. By doing so, it addresses the broader industry issue of underutilized BI resources, emphasizing the importance of data presentation and user experience in the design of such tools.

The research methodology integrates theoretical BI principles with the practical Kimball Lifecycle approach, encompassing requirement gathering, data modeling, ETL (Extract, Transform, Load) processes, and deployment. Within the operational environment of Redmond Farm Kitchen, this methodology involves hands-on development and iterative testing to ensure the dashboard is aligned with sound decision theory and refined through real-world business application. This approach ensures the BI dashboard meets operational needs by continually adapting to feedback and real-time data integration.

In summary, this chapter sets the stage for a project that bridges the gap between BI technology and its practical deployment in the restaurant industry. It outlines the motivation behind the dashboard's development, the specific challenges it seeks to overcome, and the practical contribution it aims to make to Redmond Farm Kitchen's staffing efficiency and cost management.

The organization of this thesis is as follows: Chapter 2 reviews related work, providing a comprehensive understanding of BI's role and evolution in the restaurant industry. Chapter 3 details the methodology, focusing on the Kimball Lifecycle approach and its application in developing the BI dashboard. Chapter 4 presents the results of the dashboard implementation and discusses its impact on Redmond Farm Kitchen's operations. Finally, Chapter 5 concludes the thesis with a summary of findings, limitations, and recommendations for future research.

# 2. Related Work

In this chapter we present a comprehensive review that demonstrates the pivotal role of BI in the restaurant industry. This review supports the development of a real-time dashboard for Redmond Farm Kitchen, focusing on the evolution, application, challenges, and prospects of BI in restaurants. Its particular emphasis is on enhancing staffing efficiency through the use of real-time data analysis and dashboards.

Initially, (section 2.1) sets the stage by highlighting the significance of BI in the restaurant sector. It aims to establish a foundational understanding of BI's role in restaurants, particularly in the context of staffing and operational efficiency. In (section 2.2), we follow the evolution of BI in restaurant management, showing how technological advancements have progressively shaped BI's application in restaurant operations. This historical perspective provides essential context for understanding the current state and potential of real-time BI systems in staffing management.

Following that, (section 2.3) examines how real-time analytics, an important and evolving component of BI, can be leveraged to optimize staffing processes in restaurants, directly impacting efficiency and service quality. In (section 2.4), we address the practical obstacles and considerations in developing and deploying BI dashboards. This section is important for understanding the limitations and requirements of successful dashboard implementation.

Finally, (section 2.5) concludes the review by summarizing the key insights and suggesting future directions for research in this area, highlighting potential innovations in BI within the restaurant industry.

## 2.1. Business Intelligence in Restaurants

In the dynamic realm of the restaurant industry, BI systems have emerged as transformative tools, redefining the way data is leveraged for strategic and operational decision-making. Although BI is relatively new to the restaurant world, its effectiveness is well-established in other sectors, such as retail and finance. Khan et al. (2020) emphasizes the pivotal role of BI systems in converting raw data into “business-friendly information”, thereby transforming this data into actionable knowledge and intelligence. This crucial transformation of data to knowledge plays a significant role in enhancing operational, tactical, and strategic decision-making within restaurants, offering insights that can lead to improved customer service, optimized resource management, and increased profitability.

The current landscape of BI in the restaurant industry includes a vast array of analytics, data management tools, reporting systems, and diverse data sources. These tools offer restaurant management numerous options for customization and optimization according to their specific needs and are designed to boost data visibility in operations, customer satisfaction, and profitability.

Building on this understanding, a key article by Roy et al. (2022) explores how restaurateurs can leverage analytics in strategic and operational decisions, and how researchers can pioneer innovative studies in this field. The advent of smart technologies, such as AI-driven tools for analyzing customer behavior, has expanded the data available to restaurants, providing deeper insights into customer preferences and behaviors. These technological advancements have been integral to the growth of BI in the restaurant industry, a recurring theme in our research. In (section 2.2), we will dig deeper into these technological advancements and their specific applications in the industry.

In optimizing restaurant operations, the application of BI systems is multifaceted, extending from front-of-house activities to back-end processes. A diverse array of data sources is integral to this optimization. An example is shown in Figure 1, which includes the Point of Sale (POS) system, reservation systems, valet management, feedback mechanisms, loyalty programs, and kitchen management systems. Each of these systems contributes unique data points, such as car type and time billed for valet services, reservation frequencies, customer feedback, and kitchen inventory levels, which can be leveraged for strategic decision-making (Roy et al., 2022).

| Valet management | Reservation system | POS system | Feedback system | Loyalty program | Kitchen system |
|---|---|---|---|---|---|
| Car type | Visit number | Order type | Customer feedback | Loyalty points | Current quantity |
| Billing to valet time | Visit recency | Order items | Birthday | Redemption frequency | Reordering point |
| | Visit day and time | Order value | Gender | Redemption quantity | Recipes |
| | Visits per outlet | Discount | Age | | Preparation time |
| | Waiting time | Table types | | | Wastage source |
| | Seating time | Table count | | | Wastage quantity |
| | Group size | | | | |

*Figure 1 - Example of data sources in restaurants from Roy et al. (2022).*

The POS system, for example, captures not just transactional data like order types and values but also granular details such as table types and counts, which are crucial for understanding dining preferences and staffing efficiency. Similarly, reservation systems provide insights into visit patterns and waiting times, which are essential for forecasting demand and managing labor effectively. For the scope of our research, real-time dashboard development in restaurants, we will cover our data sources in a later chapter (chapter 3).

Moreover, feedback systems and loyalty programs offer a rich source of customer data, including demographics and behavioral patterns. This can inform personalized marketing strategies and customer engagement initiatives. In the kitchen, data points related to current inventory levels, reorder points, and wastage can be pivotal in streamlining operations and reducing costs.

The integration of this data into a dashboard allows for a comprehensive analysis of restaurant operations. For instance, by examining data from the valet management system alongside POS sales data, management can assess the correlation between customer spend and valet utilization. This data visibility can reveal patterns and opportunities that isolated datasets may not, enabling restaurateurs to make more informed decisions that enhance overall efficiency and customer satisfaction.

Fernandes et al. (2021) illustrates the potential of integrating real-time social media feedback with traditional sales data to create dynamic dashboards that reflect both customer sentiment and financial performance. The use of BI tools in this innovative way not only facilitates a more agile response to market trends but also allows restaurants to fine-tune their operations in alignment with customer feedback.

Ultimately, the strategic application of BI tools, as explored by Roy et al. (2022), enables the extraction of valuable insights from these varied data sources, empowering restaurants to improve service delivery, optimize resource management, and heighten profitability. The advent of predictive

analytics in BI dashboards welcomes a new era in restaurant management, where data-driven insights are harnessed to secure a competitive edge in a dynamic market.

## 2.2. Evolution of BI in Restaurant Management

The field of BI in restaurant management has recently experienced significant growth. This trend is particularly noticeable from 2018 to 2020, with a surge in research publications, shown in Figure 2, underscoring the sector's evolving dynamics (Roy et al., 2022). This increase is largely attributed to the availability of richer data, coupled with advancements in statistics, machine learning, and optimization techniques (Mišić & Perakis, 2020). Complementing this trend, Elkhwesky et al. (2023) noted a marked increase in publications focusing on “business performance” and “restaurant”, reflecting the intensifying academic interest in this area. Their results are reflected in Figure 3.

When compared side by side you can see that the two independent studies yielded similar results when examining academic restaurant publication trends. We should note that the authors, Roy et al. (2022) and Elkhwesky et al. (2023), used different search terms (“restaurant analytic” and “business performance and restaurant” respectively) in their research of academic literature.

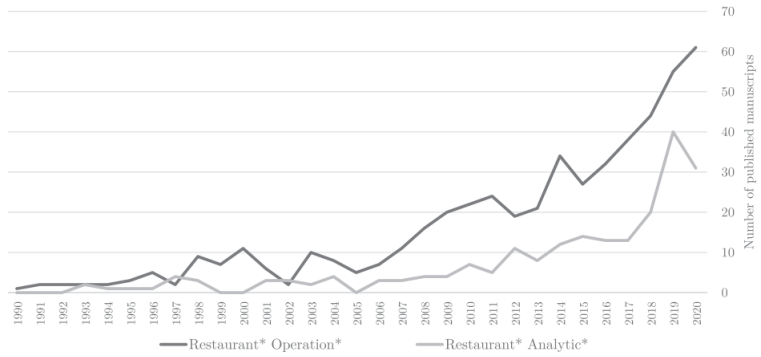



*Figure 2 - Trend of research publications in restaurant management from Roy et al. (2022).*

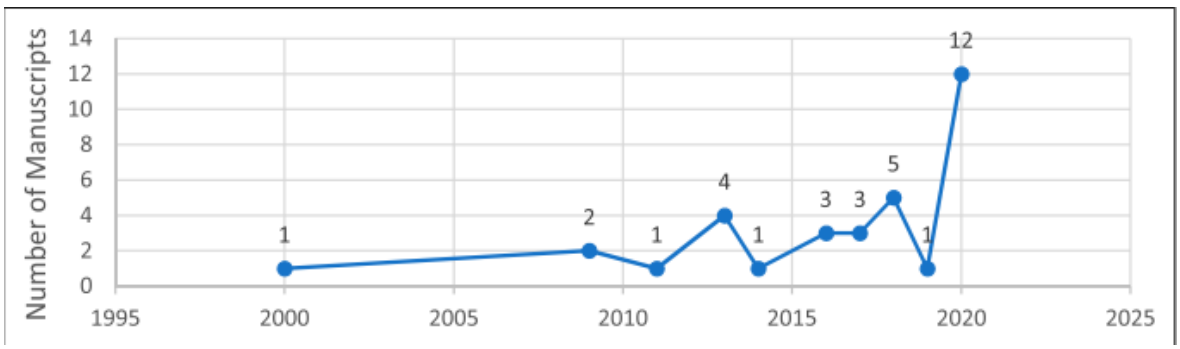



*Figure 3 - Trend of research publications focusing on “business performance” and “restaurant” from Elkhwesky et al. (2023).*

The profound impact of the COVID-19 pandemic on the restaurant industry cannot be overstated. It sparked a rapid technological adaptation and escalated the demand for carryout and delivery services (Swink, 2022). This transition, observed in our research and personal experiences, marked a notable shift in consumer behavior. People increasingly opted for food delivery or pick-up,

reducing human contact in restaurants. This behavior not only promoted the integration of more technology in the industry but also generated a wealth of data for analysis.

The acceleration of technology in the restaurant industry, catalyzed by the pandemic, has been remarkable. Smart technologies, including artificial intelligence and QR codes, have been integral in enhancing customer satisfaction and service quality (Tuncer, 2020). The advent of automation, employing devices like mechanical robots and computer networks, has streamlined operations and minimized human labor in both hotels and restaurants (Yazina et al., 2022).

Social media's role in customer engagement has become increasingly vital, with specific strategies in post attributes significantly boosting customer interactions (Gruss et al. 2020). Technologies such as 3D-food printing and mixed-reality experiences are now at the forefront of enriching dining experiences without detracting from the essence of eating (Mueller et al., 2022).

Innovations like blockchain technology are being explored to introduce cost-effective and regulated processes in catering (Gao et al., 2020). Liu (2020) showcases how advanced decision-making technologies are utilized in the restaurant industry to assess service quality. They employed a sophisticated questionnaire to gather consumer opinions on critical aspects like food quality, atmosphere, and service speed across four restaurants. This method, using a 2-tuple linguistic variable system, allowed for a detailed and quantified analysis of customer feedback (Liu, 2020). This approach exemplifies the impact of such technologies in enhancing service quality evaluation and competitive positioning in the restaurant industry.

The evolution of BI in restaurant management is marked not just by technological advancements and external factors but also by a growing emphasis on real-time analytics and industry specific solutions. The increasing sophistication of BI tools, particularly evident in the context of predictive analytics in BI dashboards, demonstrates a significant progression in restaurant management practices. This evolution is exemplified by the study of Halim et al. (2019), who applied Market Basket Analysis (MBA) using BI tools to predict consumer consumption patterns, and Fernandes et al. (2021), who proposed integrating live social media customer feedback with historical sales data for efficient restaurant management. These studies highlight the dynamic nature of BI in adapting to contemporary challenges and opportunities in the restaurant industry.

Incorporating social media feedback, sales data, and customer reviews into the decision-making process has become increasingly significant. As previously mentioned, Fernandes et al. (2021) emphasized the role of online reviews in performance enhancement and the use of Key Performance Indicators (KPIs) derived from sales forecast models for effective decision support. The development of new performance indicators like “KPISent”, which combines business performance and customer perspective, illustrates the innovative approaches being adopted to enhance decision-making processes in restaurant management.

These technological shifts are not just responses to changing times but are reshaping the very fabric of restaurant management and customer experience. This transformation has been characterized not only by the adoption of new technologies but also by a shift in how data is being utilized for decision-making. The emergence of real-time analytics represents the next step of this evolution, signifying a move towards more dynamic, responsive, and customer-focused approaches in restaurant management.

Real-time analytics, the next frontier in BI, leverages the power of instant data processing to provide actionable insights at the moment they are most needed. This is particularly crucial in the fast-paced environment of the restaurant industry, where timely decisions can significantly impact

customer satisfaction and operational efficiency. The ability to analyze and respond to data in real-time transforms how restaurants manage everything from inventory and staffing to customer engagement and service quality.

In the following section, we will explore the realm of real-time analytics. We will examine its role in improving restaurant operations and how it is being utilized to create a more adaptive, efficient, and customer-centric dining experience.

## 2.3. Real-Time Analytics for Staffing Efficiency

In the context of the evolving restaurant industry, the integration of real-time data analytics plays a pivotal role in enhancing staffing efficiency, a focus that aligns with the development of our real-time BI dashboard for improving staffing in restaurants. Real-time analytics, explored by Wolniak (2023), marks a shift towards a more responsive and effective approach in managing restaurant operations, with a particular emphasis on staffing dynamics.

The core advantage of integrating real-time analytics lies in the ability to instantaneously analyze customer behaviors, sales trends, and inventory allowing restaurant managers to dynamically adjust staff levels and roles. During peak business hours, this capability ensures that staff are efficiently allocated to high-demand areas, optimizing resource use and minimizing wastage during slower periods. This efficiency is facilitated by advanced technologies such as high-speed data processing and machine learning algorithms, which enable organizations to base decisions on the most current data available, a strategy supported by both Wolniak (2023) and Hurwitz et al. (2015).

A significant aspect of real-time analytics is its contribution to predictive analytics, particularly for forecasting future staffing needs. As mentioned, by analyzing current sales data in real time, managers can accurately predict busy times, allowing for more effective staff scheduling and preparation. This predictive ability supports not only adequate staffing during peak times, but also aids in managing labor costs more efficiently by preventing overstaffing during slower periods, as noted by Wolniak (2023) and Charles et al. (2023). Figure 4 provides more detailed information relating to timing, purpose, data sources, analytical techniques, and outputs of real-time and predictive analytics.

| | **Real-time analytics** | **Predictive analytics** |
|---|---|---|
| Timing | Real-time or near real-time | Historical |
| Purpose | Monitor and optimize ongoing operations | Forecast future outcomes and make strategic decisions |
| Data sources | Real-time or near real-time sources such as sensors or social media feeds | Historical data |
| Analytical techniques | Streaming analytics, complex event processing, machine learning | Statistical and machine learning models |
| Outputs | Immediate insights and alerts based on real-time data | Forecasts, scenarios, and models based on historical data |

Source: Authors own work on the basis of: (Hurwitz et al., 2015; Lawton, 2019; Charles et al., 2023; Scappini, 2016; Peter et al., 2023).

*Figure 4 - Real-time vs Predictive Analytics from Wolniak (2023)*

To fully leverage the potential of real-time analytics in enhancing staffing efficiency, it is essential to monitor specific KPIs. These KPIs serve as measurable values that restaurant managers

can use to assess and refine their operational strategies effectively. Below is a table of critical KPIs (Table 1) derived from recent studies, which underscores the practical applications of real-time data in operational decision-making.

Table 1 - KPIs from recent studies

| KPI | Description | Reference |
|---|---|---|
| KPISent | Combines business performance and customer perspective, computed as a sum of four key ratios. | Fernandes et al. (2021) |
| Revenue | Total income generated from business operations, typically measured daily, monthly, or annually. | Roy et al. (2022) |
| Profitability | Measures the efficiency and financial health of the operation in generating profit. | Elkhwesky et al. (2023) |

Utilizing these KPIs allows restaurant managers to not only track performance in real-time but also adjust their strategies to meet the dynamic demands of the restaurant environment. With a clear understanding of these indicators, the deployment of BI tools can be optimized to enhance both efficiency and customer satisfaction. This strategic application of real-time analytics underscores the need for robust implementation strategies that address the inherent challenges in integrating advanced BI technologies.

However, the implementation of real-time analytics in staffing management is not without its challenges. It demands the use of advanced data analytics tools and a high level of technical expertise. To fully capitalize on the benefits of real-time analytics, investments in specialized hardware and software, as well as skilled data scientists, are essential. Ensuring data accuracy and proper integration of data sources is also crucial to the effectiveness of these systems. This requirement underscores the complexity of implementing real-time analytics in restaurant management, as highlighted by Wolniak (2023), Hwang et al. (2017), and Scappini (2016).

The strategic importance of real-time data extends beyond operational efficiency to providing a competitive edge, particularly in enhancing customer experience through more efficient and responsive operational management. As the restaurant industry continues to move in a data-driven direction, real-time analytics is becoming increasingly integral to developing more efficient, agile, and customer-responsive staffing strategies, a trend emphasized by Wolniak (2023).

In the broader landscape of Industry 4.0 (digitization and automation of industrial processes), real-time analytics emerges as a transformative force in the restaurant industry, driving advancements in operational efficiency and staffing dynamics. This technology, as highlighted by Wolniak (2023), represents a significant shift toward more agile and informed management practices. It enables a more nuanced approach to managing restaurant operations, where decisions are driven by current data and predictive insights.

Looking ahead, the role of real-time analytics in the restaurant sector is one of expansion and refinement. As restaurants increasingly embrace data-driven strategies, this technology will play a crucial role in shaping responsive and strategic staffing models. The development of our real-time BI

dashboard for Redmond Farm Kitchen is a testament to this trend, offering a tool that aligns with the industry's evolving needs. This dashboard is designed to harness the power of real-time analytics for optimizing staffing levels, a direction supported by insights from Wolniak (2023).

## 2.4. Challenges in Implementing BI Dashboards

Implementing BI dashboards in the restaurant industry presents several significant challenges. One of the primary challenges is the complexity of Business Intelligence Tools (BIT) implementation. As noted by Tripathi et al. (2020), a majority of managers find BIT implementation complex, and only a small percentage have basic BIT implemented in their firms. This complexity, coupled with a lack of skilled BI maintenance personnel, makes the implementation process challenging.

Despite its growth, the BI industry faces significant implementation challenges, as highlighted in the study by Delen et al. (2018). The authors note that the BI market, expected to reach $22.8 billion by 2020, is hindered by data management and processing issues. Their analysis revealed that nearly half of the participants in a 2014 Paradigm4 survey encountered difficulties in managing data (Delen et al., 2018). Additionally, Delen et al. referenced Gartner's (a research and consulting service) forecast that 60% of big data projects would fail to progress beyond piloting (Delen et al., 2018). The study also points to time constraints in creating and updating dashboards and the need for real-time data processing as significant barriers. These challenges, supported by findings from Forrester Consulting and Columbia Business School, are substantial hurdles to the effectiveness and decision-making processes in businesses, highlighting the critical need for advancements in BI implementation strategies (Delen et al., 2018).

The 2023 study by Wikamulia and Isa examines the complexities of adding predictive features to BI dashboards in the food and beverage sector, particularly for perishable goods like bakery items. They demonstrated this using a bakery's data and advanced techniques such as extreme gradient boosting (XGBoost) and mini-batch k-means (MBKM) for forecasting and segmentation. These methods require deep knowledge of machine learning, posing a challenge for businesses without this expertise. The study showed the effectiveness of these techniques, evidenced by the accuracy of the XGBoost model and the significant scores of the MBKM model. However, it also highlights the difficulties in applying complex analytics in real-world settings, particularly for those lacking data science skills (Wikamulia & Isa, 2023).

In their 2023 study, Burnay et al. emphasize the balance required in BI dashboard design to avoid the cognitive load extremes of overloading and underloading information, both of which can hinder decision-making. They illustrate this balance with two visuals: the first displays an overloaded dashboard (figure 5), brimming with excessive charts, graphs, and figures that could overwhelm users. The second visual counters with an underloaded dashboard (figure 6), so sparse that it risks providing insufficient data for informed decisions.

These contrasting dashboards visually underscore the inverted U-shaped relationship between information volume and decision-making accuracy discussed by Burnay et al. (2023). A dashboard cluttered with data may induce cognitive overload, making it difficult for users to process and utilize the information effectively. On the other hand, a dashboard with too little information can lead to suboptimal decision-making due to a lack of necessary data. Burnay et al. advocate for a middle ground in dashboard design, providing enough data for insightful analysis without overwhelming the user, thereby enabling better business decisions (Burnay et al., 2023).

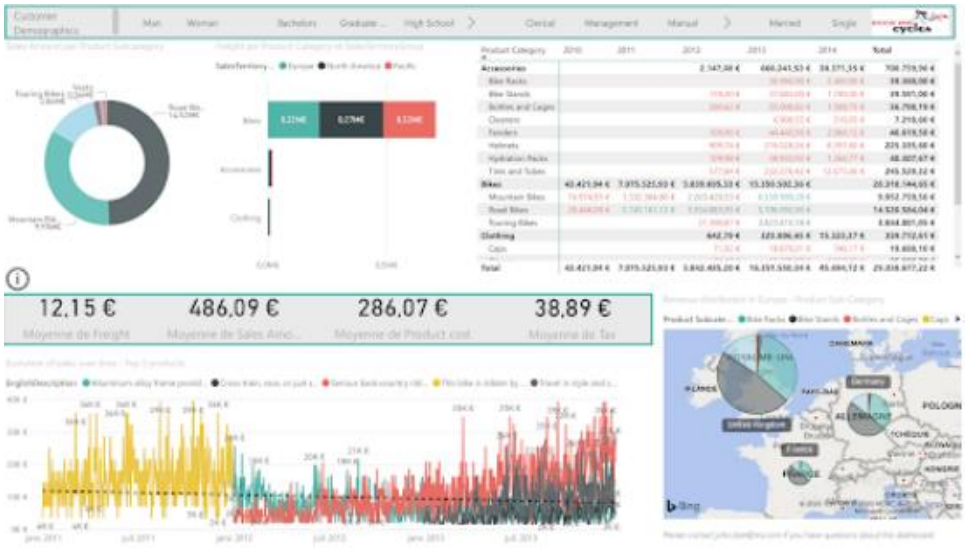



*Figure 5 - Overloaded dashboard interface example from Burnay et al. (2023)*


*Figure 6 – Underloaded dashboard interface example from Burnay et al. (2023)*

Moreover, issues related to social trust and sentiment analysis present significant challenges for BI systems. Ensuring reliability in sentiment analysis and trust inference, especially when incorporating data from various organizations, is a complex task. Additionally, with the shift of BI systems to cloud technology, data privacy emerges as a major challenge. Managing cloud environments effectively to ensure data security and privacy can be a significant obstacle for those not adept at cloud administration (Khan et al., 2020).

As we turn our focus to future directions, it's important to acknowledge that overcoming the challenges mentioned in this section paves the way for a new era in BI for the restaurant industry. An era where advanced analytics and real-time decision support systems are creating the next wave of innovation in operational and strategic management.

## 2.5. Future Directions

The future of BI in the restaurant industry is poised for significant evolution, marked by a shift towards advanced analytics, including predictive and prescriptive analytics. This paradigm shift signifies a transition from traditional BI to real-time decision support systems (Delen et al., 2018). Big Data's increasing significance across industries, including restaurants, suggests anticipated innovations in analytical techniques. Real-time analytics have become a major research area, driven by the rise of location-aware social media and mobile apps, providing a rich ground for future exploration in BI, as predicted by Delen et al. (2018).

The increasing demand for real-time business information shapes BI's future. The expectation is that businesses will become more dependent on real-time data, matching the immediacy with which information is accessed online today. This evolution means BI tools need to adapt and evolve to meet rising consumer expectations, highlighting a need for restaurants to adapt and offer timely services (Tripathi et al., 2020).

In the future, there will be an increased dependence on real-time BI in the restaurant industry. This shift, driven by the need for up-to-date information, will move beyond traditional weekly or monthly analyses, with BI tools providing more segmented and performance-related information to enhance decision-making at various organizational levels (Maaitah, 2023).

Moreover, future BI dashboards are anticipated to focus on real-time data processing and analysis. This is particularly crucial for restaurant businesses dealing with perishable goods, where market trends change rapidly, and swift decision-making based on the latest data is essential. Additionally, there is a growing need for developing industry-specific BI dashboards, emphasizing the uniqueness of each industry and the importance of customizing BI tools to cater to specific industry requirements (Wikamulia & Isa, 2023).

Future research should explore integrating multiple theoretical frameworks to better understand the complex dynamics of restaurant business performance. This includes theories like agency theory, human capital theory, and entrepreneurship theory of innovation. Additionally, there's a call for the development of a unified set of measurement tools for restaurant business performance, encompassing financial, market, environmental, and operational performance measures. The focus on environmental sustainability and various leadership styles in business performance is also crucial, given the increasing importance of environmental and social governance in the restaurant industry (Elkhwesky et al., 2023).

In summary, the future directions for BI in the restaurant industry are characterized by a greater reliance on real-time data, customization to specific industry needs, and a blend of theoretical frameworks to guide BI tool development and application. These advancements will play a critical role in how restaurants navigate the evolving landscape of data-driven decision-making.

While the literature provides a comprehensive overview of the transformative role of BI in the restaurant industry, practical implementation of these technologies often requires a structured methodological approach. The effectiveness of BI dashboards, as discussed by authors like Khan et al. (2020) and Roy et al. (2022), underscores the need for rigorous development frameworks. This research adopts the Kimball Lifecycle methodology, a well-regarded framework in the field of business intelligence, to guide the creation and implementation of a real-time BI dashboard. Details on the application of Kimball's methodology will be extensively covered in the methodology chapter of this thesis.

# 3. Methodology

In this chapter, we outline a detailed methodology that supports the creation of a BI dashboard at Redmond Farm Kitchen, essential for improving operational efficiencies and aiding strategic decision-making. This methodology, following the Kimball Lifecycle approach (Kimball & Ross, 2013), covers everything from analyzing business needs to implementing the BI system, focusing on the use of real-time and historical data within the restaurant setting. The chapter is carefully structured to walk the reader through each critical stage.

First, (section 3.1) introduces the Kimball Lifecycle methodology, highlighting its importance in aligning BI goals with the strategic requirements of Redmond Farm Kitchen. This section lays the foundation for understanding the structured process needed for developing and maintaining effective BI systems. Next, (section 3.2) dives into the data sources behind the BI dashboard, explaining how data is collected and why each type is crucial for both day-to-day operations and strategic planning.

Then, (section 3.3) describes the dimensional modeling that organizes the data, making it easier to query and report. This part is key for enabling effective real-time analysis and strategic decision-making. Following that, (section 3.4) discusses the ETL processes that ensure data moves smoothly from its origins to the dashboard.

Lastly (section 3.5) focuses on the model implementation and dashboard design, stressing user-friendly features and a system of ongoing feedback to improve BI tools. This section also covers how the design helps operational managers make quick, informed decisions, ensuring the dashboard meets both current and future needs.

## 3.1. Kimball Lifecycle

The Kimball Lifecycle methodology is pivotal for this thesis as it provides a structured, iterative process that begins with the identification of business needs and ends with the deployment and maintenance of a BI system. It emphasizes the importance of aligning BI goals with business strategies, ensuring that the BI dashboard developed not only addresses the immediate operational needs but also supports long-term strategic objectives (Kimball & Ross, 2013). This alignment is crucial at Redmond Farm Kitchen, where real-time operational adjustments and strategic foresight into business trends are valuable for maintaining competitiveness and growth.

The Kimball approach advocates for a user-centric design, which is particularly relevant for ensuring that the dashboard is accessible and effective for all levels of management within Redmond Farm Kitchen. By following this methodology, the project attempts to create a BI system that is robust, scalable, and capable of evolving with the business, addressing both current and future analytical needs. Furthermore, the iterative nature of the Kimball Lifecycle allows for continuous improvement of the BI tools based on user feedback and changing business environments, which is essential for the adaptive strategies required in the restaurant industry (Kimball & Ross, 2013).

### 3.1.1. Business Requirement Analysis

Building on the theoretical foundations laid in the literature review and the methodological framework provided by the Kimball Lifecycle, the subsequent sections map out the specific business requirements at Redmond Farm Kitchen. These requirements dictate the strategic implementation of the BI dashboard, targeting core operational efficiencies critical for the restaurant's sustained growth. Each BI goal and corresponding business question is crafted to directly contribute to enhanced

performance across various aspects of operations, from staffing efficiency to inventory and menu management.

This approach not only ensures the practical application of BI theories discussed previously but also bridges the gap between theoretical knowledge and real-world implementation, a key objective of this thesis.

### 3.1.2. BI Goals

At Redmond Farm Kitchen, the strategic implementation of a BI dashboard targets several core operational efficiencies critical to sustaining its growth and maintaining its competitive edge. The BI goals are clearly aligned with the overarching business strategy, focusing on enhancing performance across various aspects of operations:

1. **Optimize Staffing Efficiency:** The primary objective is to align staffing levels accurately with revenue demands. This involves using historical data to forecast busy periods and scheduling staff accordingly, thereby minimizing under or overstaffing at any given time.
2. **Enhance Inventory and Menu Management:** Utilizing detailed sales and product trends, the dashboard will facilitate smarter inventory controls and dynamic menu adjustments, directly reflecting customer preferences and seasonal demands.
3. **Increase Business Agility:** The dashboard is designed to provide real-time data that supports swift decision-making, allowing management to quickly reallocate resources in response to emerging trends or unexpected demands.
4. **Ensure Efficient Dashboard Deployment and Maintenance:** This involves integrating a user-friendly and reliable dashboard that supports continuous operational flow and facilitates easy maintenance and updates.

### 3.1.3. Business Questions

To effectively realize the BI goals, the following business questions need to be addressed through the dashboard functionalities. These questions shown in Table 2, guide the design and development of the BI system to ensure it meets the specific needs of Redmond Farm Kitchen.

Table 2 - Business Questions

| Business Need | Questions |
|---|---|
| Staffing Optimization | How can real-time and historical revenue data be utilized to effectively optimize staffing levels and reduce operational costs? |
| Customer Traffic Insights | What insights can the dashboard offer regarding customer traffic patterns and peak service times, using data from Cloud Retailer? |
| Inventory and Menu Decisions | How can product sales data inform strategic decisions about inventory management and menu adjustments? |
| Sales Performance Analysis | Which products have consistently performed the best and worst in terms of sales over various time frames? |
| Support for Decision Making | How do the design principles of the dashboard support quick and informed decision-making by restaurant management? |
| Deployment and Maintenance Challenges | What are the primary challenges and considerations in deploying and maintaining a real-time BI dashboard in a restaurant environment? |

Answering these questions through the BI dashboard will enable managers to not only understand and enhance current operational practices but also to forecast and adapt to future demands more effectively.

## 3.2. Data Source Exploration and Data Collection

To bridge the gap between the theoretical constructs outlined in our literature review and the practical implementation, this section explores the data sources of the BI dashboard at Redmond Farm Kitchen. It outlines the data collection methods, highlighting the significance of each source in shaping managerial decisions. This exploration is pivotal for translating the theoretical concepts discussed earlier into actionable insights within the BI system, ensuring a seamless transition from conceptual frameworks to practical applications.

### 3.2.1. Data Source Description

The dashboard leverages comprehensive sales data provided by the Cloud Retailer POS system, which is categorized into real-time and historical datasets. Each type of data plays a pivotal role in the operational analysis and strategic decision-making processes at the restaurant:

- **Real-time Transactional Data**: This data is captured continuously throughout each day, offering insights into sales trends, customer behaviors, and immediate operational requirements. It is crucial for making on-the-fly adjustments in staffing and inventory management, enabling the restaurant to respond dynamically to immediate business conditions. An example of this report from Cloud Retailer can be seen in Figure 7.

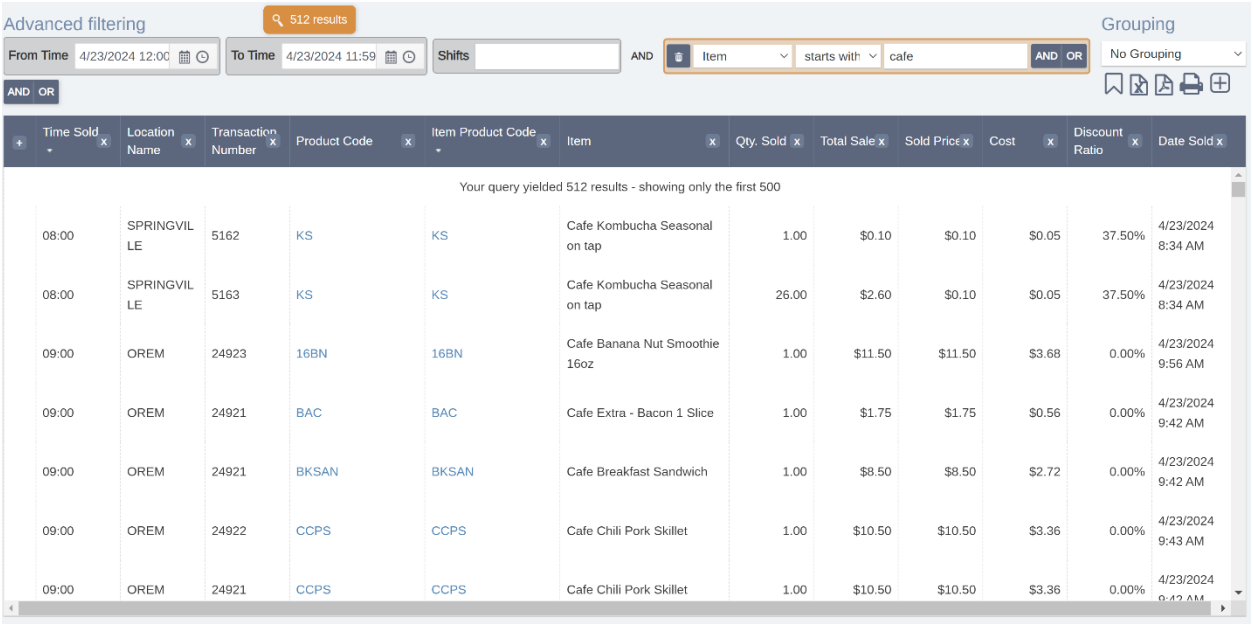



*Figure 7 – Real-time report from Cloud Retailer*

- **Historical Transactional Data**: Comprising aggregated sales data from January 1, 2023, up to the last day of the previous month, this dataset supports monthly updates. It is invaluable for analyzing longer-term sales trends, seasonal variations, and assessing the impact of past business decisions, providing a foundation for future strategic planning. An example of the report being integrated monthly can be seen in Figure 8.

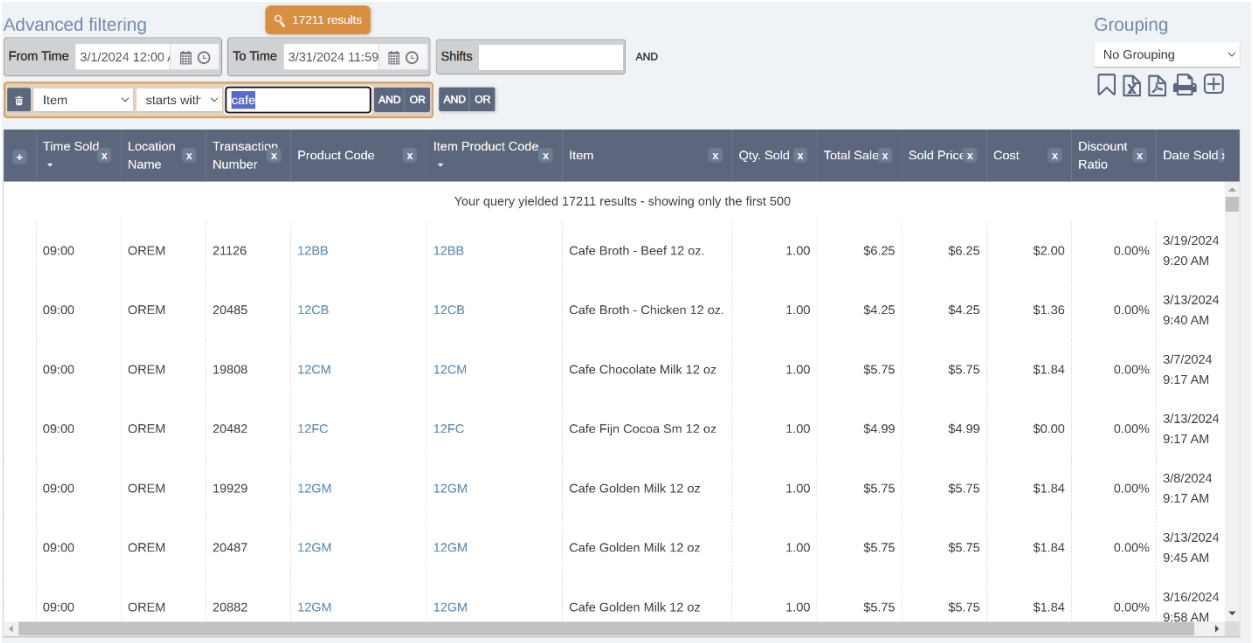



*Figure 8 - Historic monthly sales report from Cloud Retailer*

### 3.2.2. Quality, Volume, and Relevance

- **Volume and Transaction Analysis**: The restaurant POS handles an average of 221.04 transactions per day, with peak activity reaching 20.09 transactions per hour. This high volume of sales data provides a robust basis for operational analysis and decision-making.
- **Sales Variability**: The standard deviation in daily sales is approximately $956.15, reflecting significant day-to-day fluctuations that are vital for resource management and planning.
- **Peak Sales Hours**: The analysis identifies 12 PM, 1 PM, and 11 AM as the peak hours for sales, indicating critical times for optimal staff allocation and inventory preparedness. This insight is clearly distinguishable in Figure 9, showing sales per hour for the previous three months.

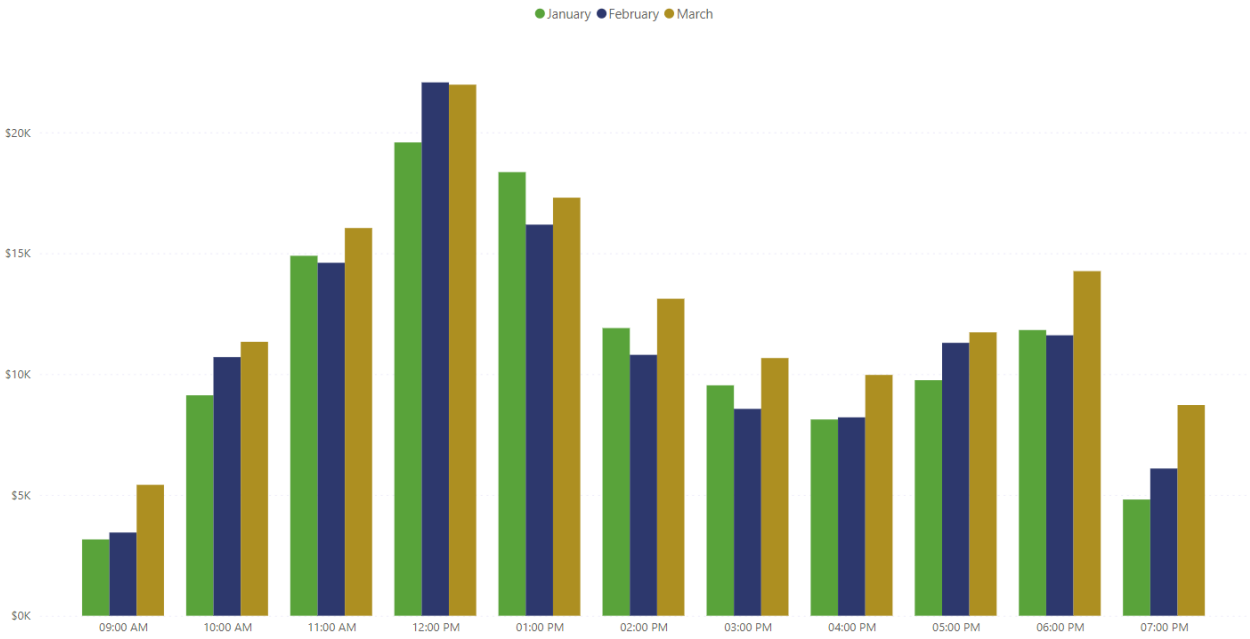



*Figure 9 - Previous 3-month trend*

- **Product Sales Insights**: Top revenue generators for the food category include the Café Farm Burger, Café Spicy Avocado Burger, and Chicken Pesto Panini. For the beverage category the Café Strawberry Flax Smoothie 16oz., Cafe Tropical Ginger Smoothie 16oz, and Cafe Banana Nut Smoothie 16oz are the leading drivers. This top-selling item information has the potential to inform menu planning and promotional strategies, aligning offerings with customer preferences.

## 3.3. Dimensional Modeling

To efficiently manage and analyze the diverse and voluminous data from Cloud Retailer, a dimensional model is utilized, comprising of fact tables for real-time and historical data, and dimensions that include time, location, and product details.

Below is a diagram illustrating the overall architecture of the data flow and dashboard (Figure 10). The goal of this dimensional model is to enable efficient data querying and reporting, while

enhancing the dashboard's capability to deliver actionable insights tailored for the specific operational needs. This facilitates both real-time decision-making and strategic long-term planning.

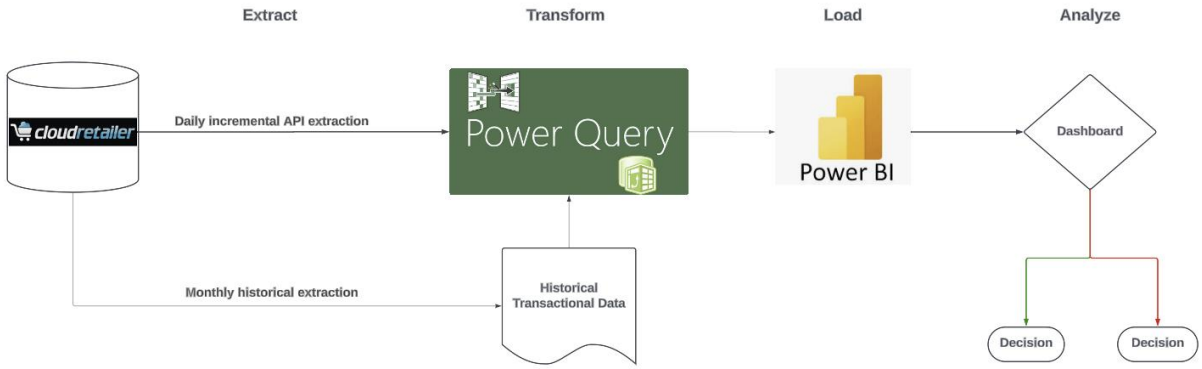



*Figure 10 – Data flow*

### 3.3.1. Fact Tables

**Fact Real-time**: This table records each transaction as it occurs, with fields for location, transaction number, item description, quantity, total price, transaction time, and date. This table (Table 3) supports the dashboard's real-time decision-making capabilities.

Table 3 - Fact real-time

| Attribute Name | Description |
|---|---|
| Date Key | Unique identifier for the date of transaction |
| Date Sold | Actual date when the item was sold |
| Item | Description of the item sold |
| Location Name | Name of the location where the transaction occurs |
| Product Code | Code identifying the product |
| Qty. Sold | Quantity of the item sold |
| Time Sold | Time at which the item was sold |
| Total Sales | Total revenue from the transaction |
| Transaction Number | Identifier for the transaction |

**Fact Historic Sales**: Similar in structure to the real-time fact table, this version is used for analyzing historical data, helping to identify trends over longer periods and aiding in more strategic, long-term planning. The attributes and descriptions can be seen in Table 4.

Table 4 - Fact historic sales

| Attribute Name | Description |
|---|---|
| Date Key | Unique identifier for the date of transaction |
| Date Sold | Actual date when the item was sold |
| Item | Description of the item sold |
| Location Name | Name of the location where the transaction occurs |
| Product Code | Code identifying the product |
| Qty. Sold | Quantity of the item sold |
| Time Sold | Time at which the item was sold |
| Total Sales | Total revenue from the transaction |
| Transaction Number | Identifier for the transaction |

### 3.3.2. Dimensions

**Dimension Time**: Contains detailed time elements such as date, hour, day of the week, and year, enabling detailed time-based analysis to optimize staffing and promotional strategies based on temporal sales patterns. The information for this crucially important table can be seen below in Table 5.

Table 5 - Dimension time

| Attribute Name | Description |
|---|---|
| Date | Date of the transaction |
| DateKey | Unique identifier for the date |
| DateTime | Full date and time stamp |
| Day | Day of the month |
| Day Name | Name of the day of the week |
| DayOfWeek | Numeric representation of the day of the week |
| Hour | Hour of the transaction |
| Month | Month of the year |
| Month Name | Name of the month |
| Time12Hour | Time in 12 hour format |
| Year | Year of the transaction |

**Dimension Location**: Includes information about each restaurant location such as name, city, and state, which is valuable for regional performance comparisons and resource allocation. This information can be seen in more detail in Table 6.

Table 6 - Dimension location

| Attribute Name | Description |
|---|---|
| Location Name | Name of the location |
| City | City where the location is based |
| State | State where the location is based |

**Dimension Product**: This dimension includes details like product code, description, size, and category, providing a comprehensive view of product performance across different segments. These attributes and their descriptions can be found in Table 7.

Table 7 - Dimension product

| Attribute Name | Description |
|---|---|
| Category | Category of the product |
| Description | Description of the product |
| Last Updated | Date when the product information was last updated |
| Product Code | Code identifying the product |
| Size | Size of the product |

This dimensional model not only facilitates efficient data querying and reporting but also enhances the dashboard's capability to deliver actionable insights tailored to the specific operational needs of Redmond Farm Kitchen. By integrating these detailed dimensions with real-time and historical data, the BI dashboard becomes a powerful tool for driving operational excellence and strategic agility.

## 3.4. ETL

The ETL process is pivotal in ensuring that data flows efficiently from the source systems to the dashboard, enabling dynamic decision-making and insightful analysis. The process is tailored to meet the specific needs of Redmond Farm Kitchen, leveraging Power BI as a self-service BI tool to enhance accessibility and user engagement.

### 3.4.1. Extraction

The extraction process at Redmond Farm Kitchen is meticulously designed to capture data at various levels of granularity and frequency to support both real-time and longer-term strategic decision-making. Daily transactional data will be captured through multiple API calls made to the Cloud Retailer database each day. This data, extracted at the transaction level using Python scripts, ensures detailed real-time monitoring and responsiveness to operational changes.

The Python script data connector in Power BI will facilitate seamless integration, enabling incremental refreshes that keep the data current without overloading the system. At the start of each month, historical sales data from the previous month is also extracted, matching the granularity of the real-time transactions to provide a consistent basis for month-over-month comparisons and trend analysis.

Additionally, a monthly update of the product catalog is implemented by uploading an Excel file from the Cloud Retailer database. This ensures that the product dimension within the BI dashboard remains updated with the latest product information, which is critical for accurate inventory and sales analysis.

### 3.4.2. Transformation

The transformation stage is conducted within Power Query, a powerful tool within Power BI designed to facilitate complex data manipulations with ease and precision. The transformations can be seen in greater detail below in Table 8.

Table 8 - Transformations in Power Query

| Transformation | Details |
|---|---|
| Real-Time and Historical Data Transformations | • Converting transaction timestamps and total amounts to appropriate data types (date/time and Fixed decimal number, respectively).<br>• Creation of a Date key to support time-based analysis and reporting.<br>• Removal of irrelevant columns such as itemProductCode, totalCost, and others that do not influence operational or strategic decisions.<br>• Filtering rows to include only relevant locations, specifically "OREM" and "SUGARHOUSE", to focus the analysis on key business areas. |
| Historic Specific Transformations | • Historical data, compiled from a folder containing past transactions, undergoes additional cleansing to remove any transactions below zero, ensuring data quality and relevance. |
| Product Dimension Transformations | • Updating the Last Updated field to a Date/time format to track changes in product details effectively.<br>• Removing the Category Department field to streamline the product information presented in the dashboard. |

### 3.4.3. Load

The final stage of the ETL process involves loading the transformed data into Power BI's data model. This model is meticulously structured to support intuitive exploration and analysis by end-users. It integrates real-time and historical data alongside product information to provide a comprehensive view of business operations.

By adhering to this structured ETL process, the BI dashboard at Redmond Farm Kitchen not only facilitates a deeper understanding of current operational practices but also equips management with the tools necessary to forecast and adapt to future demands effectively.

## 3.5. Dashboard Design

The dashboard is crafted to enhance staffing efficiency, among other operational efficiencies, through dynamic data visualization and actionable insights. This approach is intricately aligned with the Kimball methodology, which emphasizes iterative development and continuous user feedback to refine BI tools (Kimball & Ross, 2013).

### 3.5.1. User-Friendly Design

The design of the dashboard takes into consideration the principles of visual simplicity and cognitive load management, as advocated by Burnay et al. (2023), who emphasize the importance of balancing information load to avoid overwhelming users. This strategy ensures the dashboard is not only powerful in its functionality but also accessible and intuitive for users at all managerial levels.

By presenting data in a straightforward, digestible format, the dashboard enables quick comprehension and facilitates effective decision-making, essential in the fast-paced environment of restaurants. The key design features include clarity and simplicity, with the interface being clean and uncluttered to focus on displaying only the most relevant data to avoid cognitive overload.

Visual elements like graphs and indicators will be tailored to represent data in a way that directly supports business decisions, ensuring that insights can be acted upon immediately. The dashboard also incorporates a responsive design, ensuring it is accessible on various devices, crucial for operational staff who may access the data from different locations or devices within the restaurant.

### 3.5.2. KPI Metrics Linked to Business Questions

The dashboard integrates several KPIs that directly correlate with the business questions outlined in the Business Requirement Analysis (section 3.1.3.). These KPIs include:

- **Daily and Historic Revenue**: Tracks revenue performance with the ability to drill down into hourly and daily specifics.
- **Revenue by Hour/Day**: Provides insights into peak periods, helping align staffing levels and operational resources efficiently.
- **Product Revenue and Quantity Sold**: Breaks down which items are performing well, influencing inventory and menu decisions.
- **Average Transaction Value**: Offers insights into customer spending patterns, both in real-time and historically.

These metrics are designed to empower the managerial staff to make informed decisions swiftly, aligning staffing and resources with revenue pacing for optimal labor distribution and operational management.

### 3.5.3. Testing and Feedback from Operational Managers

In alignment with the Kimball Lifecycle methodology, the development of the BI dashboard at Redmond Farm Kitchen includes a critical phase of testing and iterative feedback from operational managers. This process is essential for ensuring the dashboard effectively meets the operational needs of the restaurant's daily activities (Kimball & Ross, 2013).

Operational managers will be actively involved from the outset in the testing phase, utilizing their firsthand operational experience to evaluate the dashboard's functionality and alignment with business objectives. Their involvement is crucial for identifying potential issues and ensuring the dashboard is refined to meet both immediate and future needs.

A structured feedback mechanism will be implemented, involving regular surveys and feedback sessions with management at all levels. This approach is designed to systematically collect and analyze feedback, which will be used to inform continuous improvements to the dashboard, ensuring it remains effective and relevant in a dynamic business environment.

The feedback process will be structured around a series of specific survey questions that will cover various aspects of the dashboard's usage and effectiveness. These questions are intended to gauge ease of use, performance, relevance, visual design, and overall satisfaction. Additionally, open-ended questions will invite detailed comments and suggestions for further enhancements. The proposed survey questions are displayed in Table 9:

Table 9 - Survey questions

| Category | Question | Options |
|---|---|---|
| Ease of Use | "On a scale of 1 to 10, how easy do you find navigating the dashboard?" | 1 (Very difficult) to 10 (Very easy) |
| Performance and Speed | "Have you experienced any delays or issues while loading data on the dashboard?" | Yes / No |
| Relevance and Usefulness | "Does the dashboard provide all the information you need for your daily decisions?" | Yes / No |
| Visual Design and Presentation | "Do you find the dashboard's visual design and data presentation clear and easy to understand?" | Yes / No |
| Overall Satisfaction | "On a scale of 1 to 10, how satisfied are you with the overall functionality of the dashboard?" | 1 (Not satisfied) to 10 (Very satisfied) |
| Open-Ended Feedback | "Please provide any additional comments or suggestions that can help us improve the dashboard. Are there specific features, data points, or changes you would like to see?" | N/A |

The survey will be created and distributed using Google forms allowing straightforward selection of responses and provides space for open-ended feedback. The timing of the survey distribution will be quarterly, aligning with periods when managers are less likely to be overwhelmed by operational duties.

Responses to the survey will be analyzed using quantitative methods to identify trends and common issues, while qualitative analysis of open-ended responses will provide deeper insights for targeted improvements. This comprehensive approach to gathering feedback will ensure the dashboard's functionality and user experience are continually enhanced, remaining strategically aligned with Redmond Farm Kitchen's operational goals and adaptable to the evolving demands of the restaurant industry.

# 4. Results and Discussion

Building upon the foundational discussions of the related work and methodologies outlined in previous chapters, this chapter explores the practical deployment and evaluation of the BI dashboard at Redmond Farm Kitchen. This chapter connects the theoretical aspects discussed earlier with the implementation of the BI dashboard, emphasizing its role in addressing operational challenges and enhancing efficiencies within the restaurant.

First, (section 4.1) details the technical setup and user-centric design of the dashboard. It examines how the dashboard integrates with the existing system, Cloud Retailer POS, and discusses the impact of real-time data processing on operational decision-making during business hours. This section also highlights the dashboard's design elements that facilitate user interaction and quick data-driven decisions.

Next, (section 4.2) provides details on the model implementation and the dashboard's application across various operational facets, including staffing optimization, customer traffic management, inventory control, and initial sales performance analysis. This section assesses the effectiveness of the dashboard in transforming operational practices, leveraging the specific business questions identified earlier in the thesis to evaluate practical outcomes. It also discusses the tangible and intangible benefits derived from the dashboard's implementation, covering quantitative improvements in operational metrics, such as reductions in labor costs and enhancements in menu optimization, as well as qualitative benefits like improved decision-making speed and accuracy. Feedback from users regarding the dashboard's impact is included, offering insights into its operational influence and user satisfaction.

Lastly, (section 4.3) places the practical findings within the broader context of BI technology application in the restaurant industry. It compares these results with existing literature on BI system implementations, discussing both the concordances and divergences observed. This section also reflects on the unique challenges encountered during the project, synthesizing lessons learned and suggesting future research directions and potential enhancements for the BI dashboard.

Through the discussions in each section, this chapter not only showcases the practical application of BI technologies at Redmond Farm Kitchen but also highlights the transformative potential of such tools in enhancing restaurant management practices, fulfilling the overarching objectives of this thesis.

## 4.1. Model Implementation

The Redmond Farm Kitchen dashboard is underpinned by a robust dimensional model, illustrated in Figure 11, designed to enhance data integration and support complex analytical capabilities. This model is pivotal for the subsequent dashboard functionalities as it facilitates multi-dimensional data analysis, crucial for extracting comprehensive insights from disparate data streams. The ability to correlate various data points in real-time allows the management to make informed decisions swiftly, which we believe significantly boosts operational efficiency.

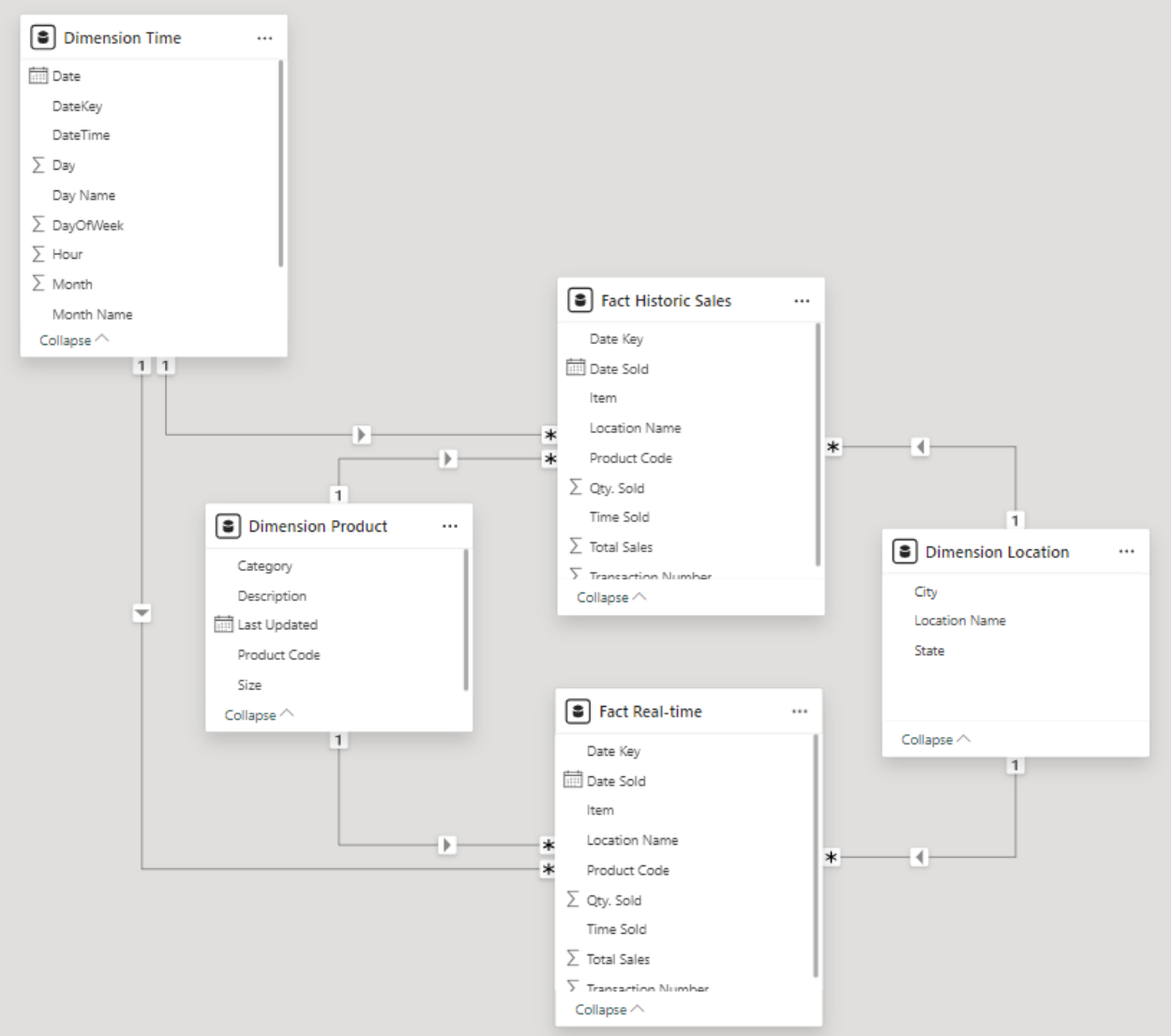



*Figure 11 - Dimensional model in Power BI*

The model features advanced data integration, refreshing during operating hours to equip management with real-time insights. These updates are crucial for optimal management decisions during the restaurant's business hours from 9 AM to 8 PM, Monday through Saturday. This integration with the Cloud Retailer POS system ensures that all transactional data is current, reflecting the latest financial and operational statuses.

### 4.1.2. User Interface Design

The daily dashboard page (figure 12) for each location is designed to be user friendly and align with the natural left-to-right reading pattern, ensuring immediate engagement with essential metrics. The "Average $ per Transaction Today" and “Average of Same Weekday Past Month” are positioned in the top left corner, making them the initial focus for users, facilitating swift and efficient data absorption.

This strategic placement aids in quicker understanding and decision-making, which is vital in the fast-paced restaurant environment.

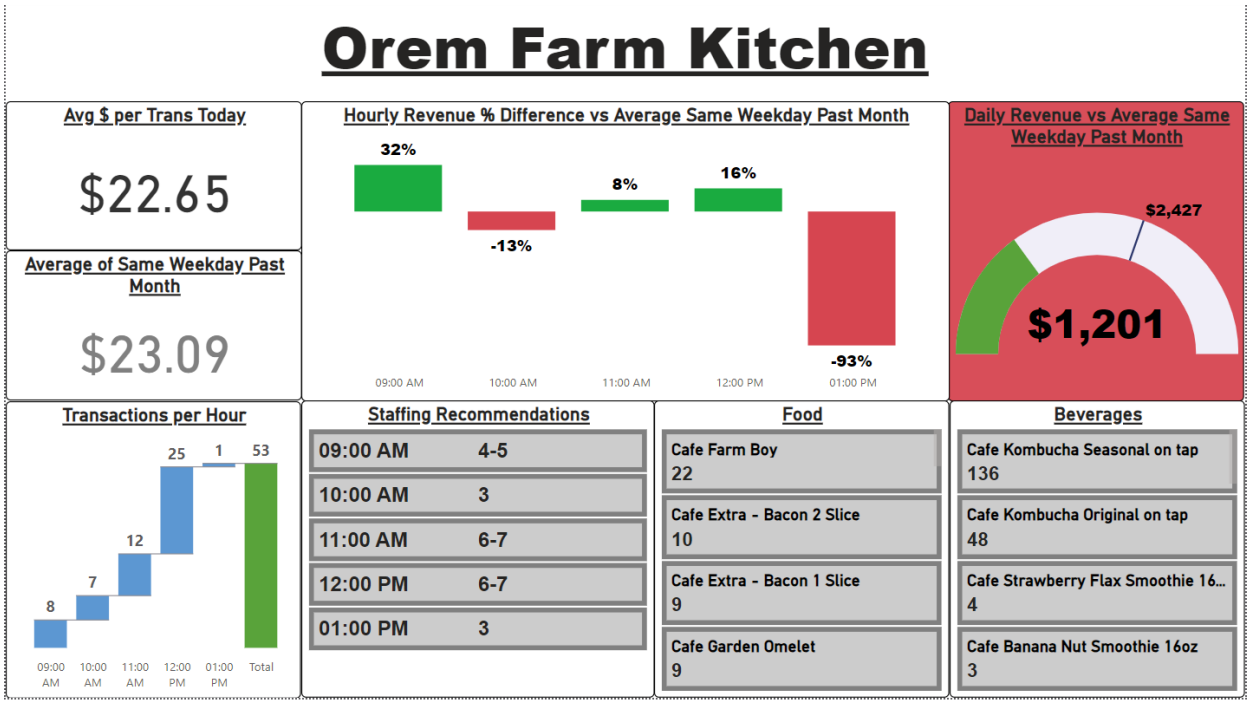



*Figure 12 - Orem location daily dashboard interface*

Moving right, the design transitions from specific to broader financial insights, displaying hourly and daily revenue comparisons through intuitive visual elements like color-coded bars and gauges. These visuals quickly convey performance relative to historical averages, with green indicating above-average results and red indicating below-average outcomes.

Below these financial metrics, the dashboard presents operational data such as transactions per hour and staffing recommendations. These sections deliver critical insights into customer flow and necessary staffing adjustments, although they derive from different metrics. The dashboard is designed to enable managers to optimize staffing efficiently based on the latest customer traffic data.

The bottom right quadrant focuses on detailed food and beverage sales, providing specific data on menu item performance. This section is crucial for understanding customer preferences and managing inventory effectively in real-time.

### 4.1.3. Revenue Pacing and Performance Tracking

Central to monitoring performance, the "Hourly Revenue % Difference vs. Average Same Weekday Past Month" bar chart provides a clear and immediate visual representation of how current revenues stack up against past averages throughout the day. As depicted in the first part of Figure 13, this chart uses colored bars—green indicating above-average performance and red signifying below-average outcomes—to facilitate quick assessment and responsive decision-making.

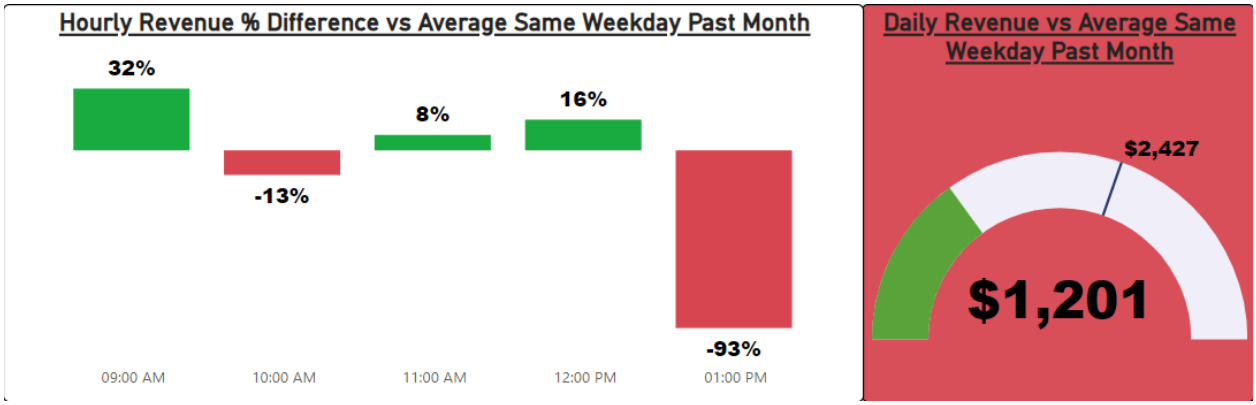



*Figure 13 - Dashboard revenue pacing tools*

Adjacent to this, the "Daily Revenue vs. Average Same Weekday Past Month" gauge chart offers a dynamic visual of the day's cumulative revenue health. This gauge features a color-coded scale where green illustrates revenues that surpass historical averages, displayed in Figure 14, and red highlights revenues falling short, as shown in the second part of Figure 13. This intuitive design aids in maintaining an ongoing evaluation of daily revenue performance, enabling timely adjustments to business strategies.

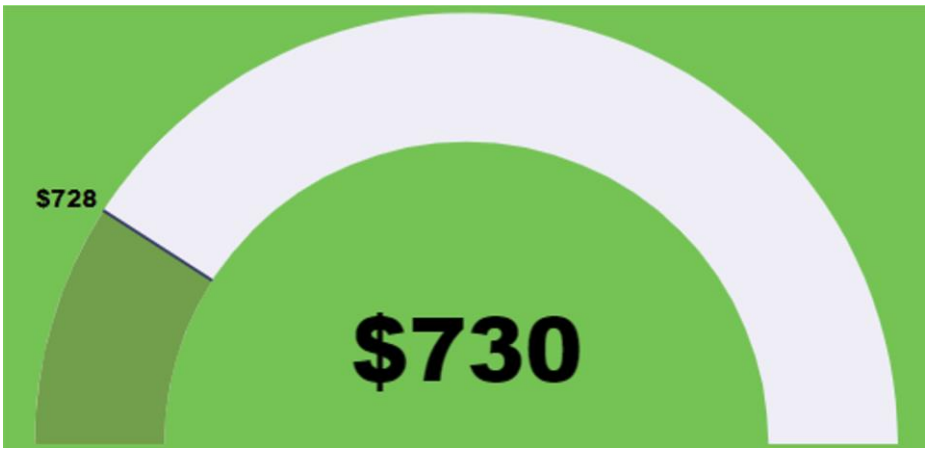


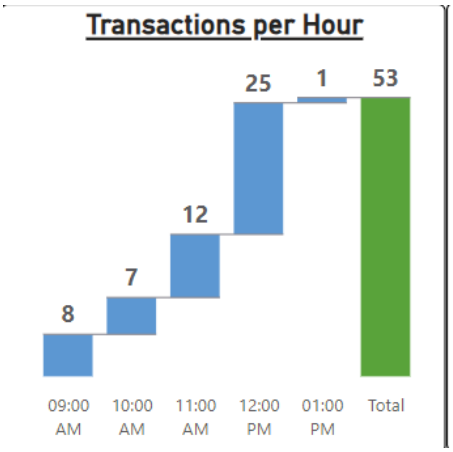

*Figure 14 - Indication of pacing ahead of historical average*

### 4.1.4. Operational Functionality and Staffing Optimization

Utilizing the daily dashboard, staffing levels are optimized through data-driven recommendations based on revenue thresholds. These recommendations are tailored to the restaurant's varying levels of activity—categorized as 'not busy', 'normal', and 'busy'—which correlate directly with distinct revenue tiers.

In tandem with revenue-based staffing recommendations, the dashboard includes a "Transactions per Hour" waterfall chart, depicted on the left in Figure 15. While separate in its foundation, as it is based on the count of unique customer visits, this chart delivers crucial insights

into the ebb and flow of customer traffic, offering additional context for operational decisions, including but not limited to staffing.




**Staffing Recommendations**

| | |
|---|---|
| 09:00 AM | 4-5 |
| 10:00 AM | 3 |
| 11:00 AM | 6-7 |
| 12:00 PM | 6-7 |
| 01:00 PM | 3 |

*Figure 15 - Waterfall chart and staffing recommendations*

To establish robust staffing thresholds, we employed a combination of quantitative analysis and managerial expertise. We initiated our approach by segmenting operational periods into distinct categories, establishing minimum staffing needs based on anticipated business levels: 3 staff for 'not busy', 4-5 staff for 'normal', and 6-7 staff for 'busy' periods. This structured classification was crafted through comprehensive discussions with management to align the staffing levels closely with operational needs, and we hope it will prove effective.

For the analytical groundwork, tools such as Google Colab and Python were instrumental in processing and analyzing a comprehensive dataset of hourly sales spanning an entire year across the different restaurant locations. We prepared the data by organizing sales according to specific time frames and excluding non-operational days, setting the foundation for a detailed analysis. Aware of the potential biases in historical data, such as anomalies or the exclusion of variables like weather, we approached the normalization of sales data with care to mitigate these issues.

Our analysis produced pivot tables that compared hourly sales by location, providing a transparent view of how sales fluctuate throughout the day and across different days of the week. Adjustments were made to normalize sales data for the number of operational days per location, ensuring that our weekly sales averages were accurate and representative.

Subsequently, we applied a percentile-based classification system to define sales volume tiers that directly impact staffing levels. Sales below the 50th percentile were deemed 'not busy', those between the 50th and 75th percentiles as 'normal', and above the 75th percentile as 'busy'. This basic framework, depicted in Table 10, enables dynamic and precise staffing recommendations grounded in actual sales data.

Table 10 - Staffing thresholds

| Location | Total Sales | Staffing Recommendation |
|---|---|---|
| OREM | < 174.11 | 3 staff |
| OREM | 174.11 - 281.94 | 4-5 staff |
| OREM | > 281.94 | 6-7 staff |
| SUGARHOUSE | < 184.81 | 3 staff |
| SUGARHOUSE | 184.81 - 258.48 | 4-5 staff |
| SUGARHOUSE | > 258.48 | 6-7 staff |

### 4.1.5. Product Performance and Inventory Management

The dashboard's lower section provides crucial insights into product performance, with real-time analytics on top-selling items in both food and beverage categories, as illustrated in Figure 16. This section is instrumental in identifying customer preferences, allowing the restaurant to adjust ingredient inventory levels and refine its menu effectively to capitalize on current sales trends.

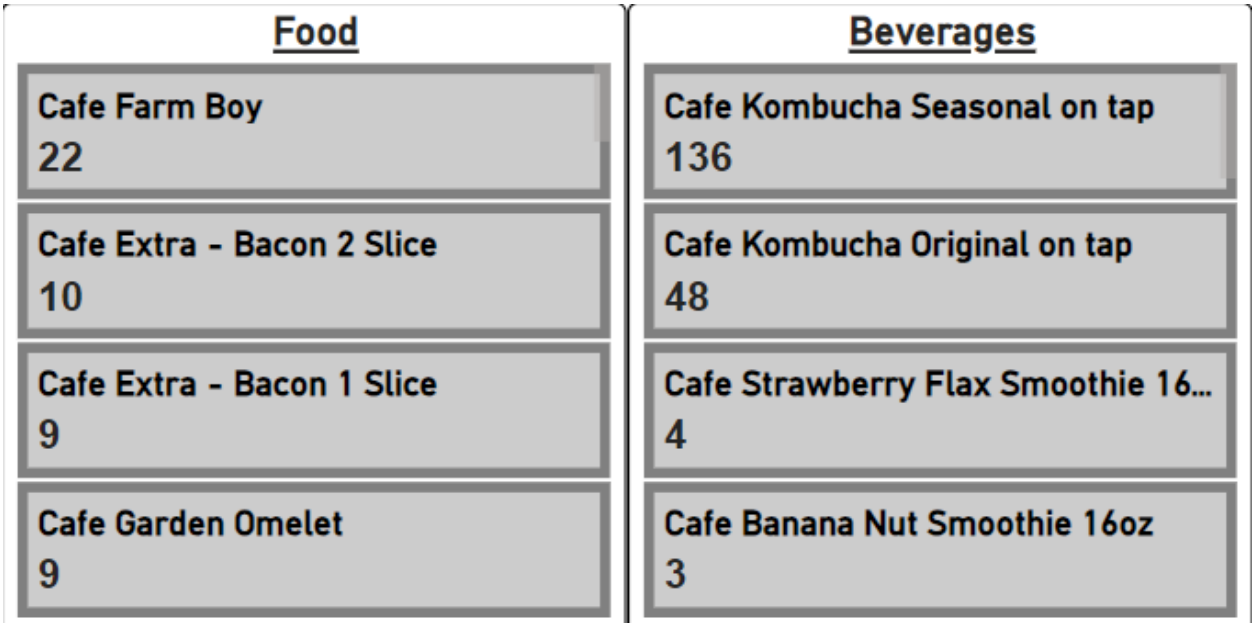



*Figure 16 - Top sellers of the day*

By closely monitoring real-time sales data, the restaurant can optimize stock levels, reducing waste and ensuring availability of high-demand items. This responsive approach to inventory management supports operational efficiency and enhances customer satisfaction by maintaining a fresh and appealing menu.

### 4.1.6. Historical Analysis

The Redmond Farm Kitchen Dashboard enhances its real-time analysis with extensive historical data views, offering both previous three-month and twelve-month overviews. These views provide comprehensive comparisons of sales and transactions over different periods, attempting to reveal deeper insights into trends and patterns that influence strategic decision-making.

In the three-month overview, shown in Figure 17, managers can analyze sales and transaction volumes by hour. This detailed breakdown helps identify peak times and discern seasonal effects, essential for tailoring operational strategies. Additionally, the top and bottom selling product data is invaluable for refining menu strategies, as it highlights consistent food and beverage preferences, enabling targeted adjustments to the restaurant's offerings.

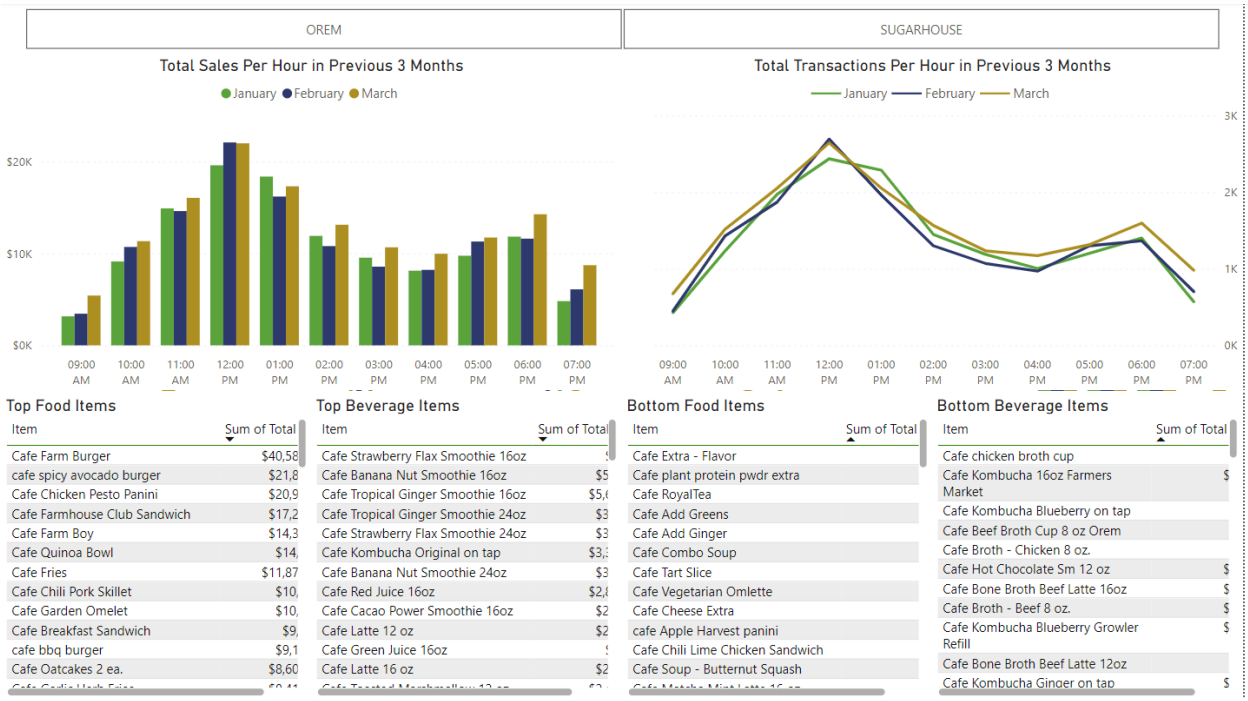



*Figure 17 - Previous 3-month historical dashboard page*

The annual view, displayed in Figure 18, expands these insights by providing an analysis of sales dynamics over a longer timeframe. It focuses on sales and transactions by category over the last year, offering a strategic lens for assessing long-term performance. The pie charts and bar graphs in this view categorize sales by segments such as lunch, beverages, and sides, while the detailed bar charts that dissect transactions per hour provide a deep dive into customer behaviors and preferences.

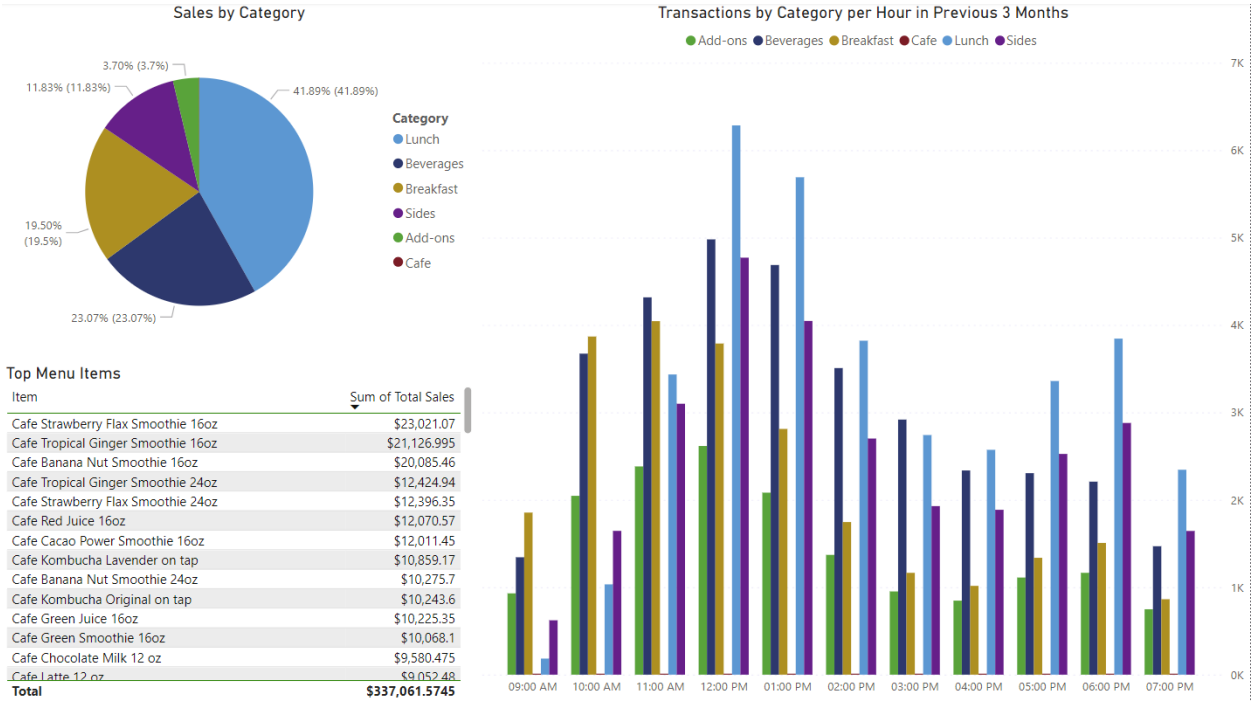



*Figure 18 - Previous 12-month historical dashboard page*

The integration of real-time and historical data ensures that the Redmond Farm Kitchen Dashboard is an indispensable decision-support tool. It not only meets immediate operational needs but also provides a strategic overview of long-term performance trends. This blend of live and historical insights puts Redmond Farm Kitchen in a prime position for operational efficiency and customer satisfaction within the restaurant industry.

## 4.2. Results Analysis and Business Impact

We believe that the integration of real-time and historical data in the form of a user-friendly dashboard has fundamentally transformed staffing practices, aligning staff scheduling closely with observed revenue peaks and customer traffic patterns. This strategic use of data has enabled the restaurant to optimize labor costs and enhance operational efficiency effectively.

### 4.2.1. Staffing and Operational Efficiency

Previously dependent on estimations and past experiences, staffing decisions are now driven by robust analytics that capture real-time customer flows alongside historical trends. This shift has supported optimal staffing during peak times and prevented overstaffing during quieter periods. Managers utilize the historical pages of the dashboard to anticipate busy periods, adjusting staffing schedules accordingly to handle increased customer volumes. During expected slow hours, staffing is reduced, and employees are reallocated to prep or carry out administrative tasks, maximizing productivity without sacrificing customer service quality.

We believe this approach mirrors revenue and traffic patterns, allowing managers to adjust staffing in various kitchen areas based on the specific demands of each part of the day. For instance, during late mornings and early evenings when customer traffic spikes, the kitchen grill, beverage station, and customer service areas are adequately staffed to maintain high service standards.

Conversely, during anticipated downtimes, fewer staff are needed, which helps in reducing idle labor costs.

The visual in Figure 19 provides a clear before-and-after comparison of staffing adjustments, demonstrating the improvements in labor allocation. This figure depicts the shift from traditional scheduling methods to data-driven staffing strategies, illustrating how the restaurant has streamlined its operations to better match the natural ebbs and flows of customer traffic.


*Figure 19 - Staffing schedule adjustments*

By leveraging detailed insights from the BI dashboard, managers are making informed decisions that optimize staffing based on hourly, daily, and weekly trends. We believe this level of detailed analysis supports fine-tuning operational strategies, significantly enhancing overall efficiency and setting a new standard in labor management for the business.

### 4.2.2. Customer Traffic Insights

The dashboard's detailed analysis of customer traffic patterns has significantly enhanced operational flow by enabling a more responsive and efficient approach to managing peak times and optimizing customer service. The insights from the dashboard have allowed managers to anticipate and prepare for fluctuations in customer traffic effectively, transforming how the restaurant handles its busiest periods.

By accurately identifying peak times, management has focused additional resources on kitchen areas that experience the most pressure during these rushes. Practical adjustments, such as preparing samples to distribute to waiting customers, aim to enhance the customer experience during longer wait times. Additionally, kitchen staff prepare ready-to-go takeout items that are likely to be in high demand during periods of increased foot traffic. These proactive measures ensure that service remains swift and efficient, even during unexpected surges in customer visits, maintaining high levels of customer satisfaction.

A critical insight from the dashboard has been the identification of a newly prominent rush hour between 5-7 PM, as can be seen in Figure 20. This time of day was previously unrecognized as a peak period for the restaurant, which has traditionally been known more for its breakfast and lunch offerings. We believe this newfound data has highlighted increased customer activity during dinner hours, prompting a strategic shift in how the restaurant views its service capabilities beyond the traditional day parts.

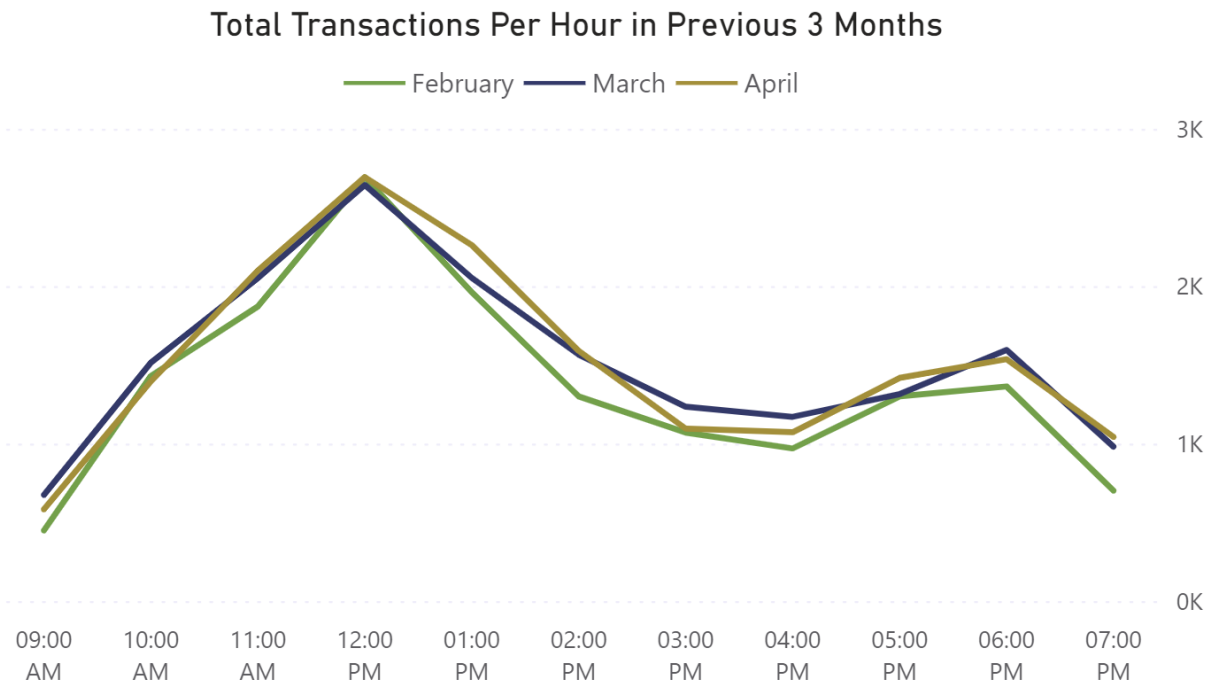



*Figure 20 - Total transactions per hour in previous 3 months*

The recognition of these dinner time peaks has led management to expand dinner menu options, experimenting with new dishes and specials that cater to the evolving customer base. This adjustment not only meets the demand but also taps into new revenue streams, enhancing the restaurant's visibility and appeal during the dinner hours. The dashboard's role in uncovering these trends demonstrates its value not just in operational management but also in strategic planning, helping to align the restaurant's offerings with actual customer behavior and preferences.

Through the effective use of the BI dashboard, Redmond Farm Kitchen has adapted its operations to try to align with customer traffic patterns. This adaptation has improved operational efficiency and enhanced the customer dining experience, ensuring that the restaurant can continue to thrive and expand its reputation as a versatile dining destination.

### 4.2.3. Inventory and Menu Decisions

The dashboard has influenced inventory management and menu planning by providing real-time and historical data on customer preferences and sales trends. The BI tool allows managers to precisely assess which menu items are performing well and adjust ingredient preparation accordingly. Instead of preparing a standard quantity of all ingredients throughout the day, kitchen staff now focus on what is selling, significantly reducing waste and the time spent preparing less popular items.

This targeted approach to inventory management is particularly effective in handling the restaurant's diverse menu, which includes both staple dishes and seasonal specials. The dashboard's insights enable the kitchen to keep pace with sales fluctuations, ensuring that ingredients are fresh and available without overstocking, which traditionally led to higher waste levels.

Seasonal menu adjustments have also become more data-driven. Redmond Farm Kitchen frequently introduces new dishes that incorporate fresh, local ingredients, aligning offerings with

what's in season. These items, while popular as specials, historically had their permanence on the menu influenced by subjective factors, such as preferences expressed by patrons or staff close to management. We hope this data-driven approach will lead to more objective and effective menu decisions. This shift to a more objective, data-informed approach allows the restaurant to better cater to actual customer demand and optimize menu profitability.

As previously mentioned, the dashboard has highlighted an increase in dinner sales, prompting strategic enhancements to the dinner menu. Management has been able to capitalize on this trend by testing and analyzing the performance of new dinner items through the dashboard. This method of continuous feedback and adjustment ensures that only the most successful dishes make it to the permanent menu, aligning offerings with customer preferences and seasonal availability.

Overall, the integration of the BI dashboard into daily operations at Redmond Farm Kitchen has not only streamlined inventory and menu management but also enhanced the restaurant's ability to adapt to customer demands in real-time. This has led to a more efficient kitchen operation, reduced waste, and a menu that dynamically adjusts to both customer preferences and seasonal ingredients, ensuring that the restaurant continues to deliver high-quality, appealing food.

### 4.2.4. Initial Sales Insights

The initial data extracted from the dashboard has pinpointed high-performing products as well as underperformers. This insight has enabled the management to dynamically adjust their sales and marketing strategies—promoting best-sellers more aggressively and reevaluating or repositioning items that are lagging, which we believe will enhance overall performance. For example, the Farm Burger consistently shows strong sales during the dinner rush, prompting management to increase its availability and prominence on the menu during those hours. In addition, the kitchen has started to run a promotion during the 5-7pm hours, giving fries and drinks at a reduced price to customers who order the Farm Burger.

Moreover, preliminary revenue patterns revealed by the dashboard have shed light on specific times of day and menu items that drive the highest sales. This has been particularly transformative for planning and forecasting. An example of this can be seen in one of the visuals on the annual page of the dashboard, shown in Figure 21. We believe that understanding these patterns allows for more precise inventory control and staffing, aligning resources more closely with actual sales activity. It has also prompted targeted marketing campaigns designed to boost customer turnout during identified peak times, enhancing overall revenue potential.

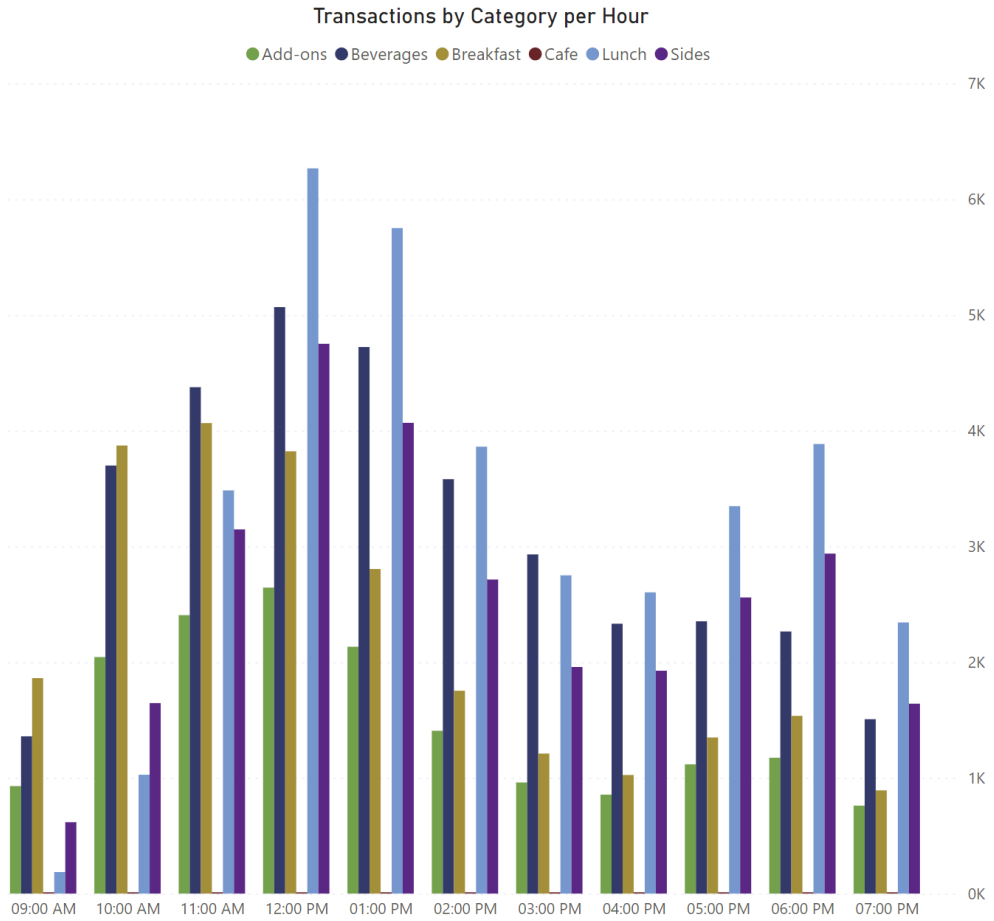



*Figure 21 - Transaction by category per hour for previous 12 months*

These insights have not only fostered a more responsive operational approach but have also contributed to a more strategic overview of business performance. The immediate impact of the BI dashboard on sales strategies at Redmond Farm Kitchen exemplifies the powerful role of data-driven decision-making in enhancing business outcomes. We believe the ability to quickly interpret and act on sales data ensures that the restaurant remains agile and competitive in a dynamic market environment.

### 4.2.5. User Feedback

To evaluate the effectiveness and user satisfaction of the newly implemented BI dashboard, a survey was conducted among management and users within the kitchen environment. The survey aimed to gather insights on various aspects of the dashboard's functionality, including ease of use, performance, relevance, visual design, and overall satisfaction. A total of 8 responses were collected, providing valuable feedback that will help guide future enhancements and optimizations of the dashboard. The responses are summarized in Table 11, which highlights key metrics and open-ended feedback provided by the users:

Table 11 - Survey results

| Response | Ease of Use (1-10) | Performance and Speed (Yes/No) | Relevance and Usefulness (Yes/No) | Visual Design and Presentation (Yes/No) | Overall Satisfaction (1-10) | Open-Ended Feedback |
|---|---|---|---|---|---|---|
| 1 | 8 | No | Yes | Yes | 9 | Positioning staffing recommends closer to % difference chart would be helpful. |
| 2 | 7 | Yes | Yes | Yes | 8 | Very useful, sometimes slow loading times tho |
| 3 | 8 | No | Yes | Yes | 8 | Great tool! Perhaps adding a feedback feature for users to suggest real time improvements. |
| 4 | 9 | No | Yes | Yes | 10 | Awesome- would be cool to include some CX metrics like google reviews. |
| 5 | 7 | No | Yes | Yes | 8 | Very intuitive. Adding a seasonal section from the menu would be perfect. |
| 6 | 10 | No | Yes | Yes | 10 | n/a |
| 7 | 8 | No | Yes | Yes | 8 | Overall, very impressive. Can we get one for the store side? |
| 8 | 9 | No | Yes | Yes | 9 | Really effective. Adding a section for seasonal trends might be nice. |

Key points from selection-based feedback include:

- **Ease of Use**: Scores ranged from 7 to 10, indicating that most users found the dashboard to be user-friendly. The average score in this category was 8.25, suggesting a high level of usability.
- **Performance and Speed**: A respondent noted issues with the dashboard's loading times, indicating a potential need for improvements in data processing and display speed.

- **Relevance and Usefulness**: All users affirmed the relevance and usefulness of the dashboard, illustrating its effectiveness in providing necessary operational data to the kitchen staff.
- **Visual Design and Presentation**: The majority of users were satisfied with the visual design and presentation, with only one user dissenting, pointing towards room for minor enhancements.
- **Overall Satisfaction**: Overall satisfaction scores were also high, ranging from 8 to 10, with an average of 8.75, reflecting strong user satisfaction with the dashboard.

Key points from the open-ended feedback include:

- A user suggested closer positioning of staffing recommendations to the percentage difference charts for enhanced readability and utility.
- Feedback on performance highlighted a common issue with slow loading times, suggesting a need for technical improvements.
- Users appreciated the dashboard's utility and suggested additional features, such as a feedback mechanism for suggesting real-time improvements and inclusion of customer experience (CX) metrics.
- There were requests for expanding dashboard features to include more specific sections, like seasonal trends and a dedicated section for seasonal menu items, which could help in making more informed decisions related to menu adjustments.
- One user expressed a desire to see similar dashboard functionalities extended to the retail side of the business, indicating potential areas for expansion.

These insights from the direct users of the BI dashboard underscore the tool's impact on operational efficiency and staff satisfaction while also highlighting areas for improvement. The feedback collected is invaluable for the continuous development cycle of the dashboard, ensuring that it not only meets the current needs of its users but also adapts to changing requirements and enhances functionality over time.

## 4.3. Discussion

The implementation and evaluation of the BI dashboard at Redmond Farm Kitchen, as discussed in preceding sections, not only demonstrates the operational benefits of BI systems in restaurant management but also solidifies the thesis's dialogue with existing scholarly work on business intelligence. This discussion integrates the project's findings with the theoretical frameworks explored in the literature review, specifically addressing how real-time analytics enhance operational efficiency and decision-making in restaurant settings.

As previously outlined in Sections 2.1 and 2.3 of the literature review, business intelligence plays a transformative role in restaurant management by enhancing staffing efficiency through real-time data analysis. The BI dashboard developed for Redmond Farm Kitchen exemplifies this application by allowing for dynamic staffing optimization. This practical outcome directly addresses the theoretical discussions by Wolniak (2023), who emphasizes the strategic importance of real-time analytics in staffing management. The dashboard’s real-time updates during peak business hours ensure optimal staff allocation, mirroring the potential of BI tools discussed in the literature to enhance operational efficiency and customer service quality.

Moreover, the challenges related to BI dashboard implementation, such as technical integration and user adoption discussed in Section 2.4, were encountered in this project. The iterative feedback mechanisms and user-centric design principles adopted here align with the strategies recommended by Khan et al. (2020) for overcoming these hurdles. By engaging end-users from the operational management team in the dashboard's design and refinement process, the project not only enhanced user experience but also ensured that the dashboard met the practical needs of Redmond Farm Kitchen, demonstrating a successful application of theory to practice.

We believe the results from the dashboard implementation further emphasize the substantial impact of real-time data on operational efficiency, a key benefit observed across similar BI implementations in the sector. For instance, the ability to adjust staffing levels dynamically based on actual customer flow, as detailed in Section 4.1.4 of the results, directly corresponds to improved labor cost management and enhanced service delivery—outcomes that echo the advantages of real-time analytics highlighted by Hurwitz et al. (2015).

Additionally, the initial survey of operational managers highlighted high satisfaction levels with the dashboard's ease of use, performance, relevance, and visual design (see Figure 22). Suggestions for improvements, such as closer positioning of related metrics and the inclusion of seasonal trends and customer experience metrics, were gathered for future enhancements.

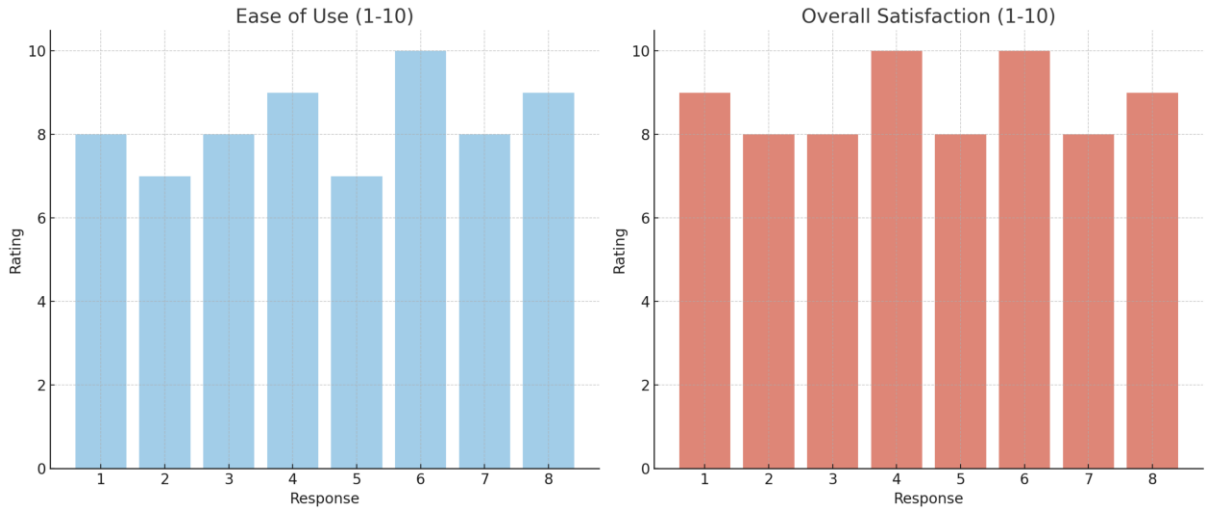



*Figure 22 - Ease of use and overall satisfaction*

In addition, the project explores the strategic application of BI tools in refining menu offerings and inventory management, aligning with the discussions in Section 2.5 of the literature review on the potential of BI to transform operational strategies. We believe the data-driven insights provided by the dashboard enable Redmond Farm Kitchen to tailor its menu dynamically, reducing waste and aligning offerings with customer preferences.

The implementation of this dashboard does more than just operationalize theoretical concepts; it enriches the ongoing discourse in the academic community about the practical applications of BI in the restaurant industry. By showcasing a successful integration of real-time and predictive analytics in daily operations, we hope this project provides empirical evidence supporting the theoretical benefits of BI discussed in the literature. It highlights the critical role of user

engagement in the successful adoption of BI tools and illustrates the potential for BI systems to significantly enhance operational decision-making and strategic planning in restaurant management.

Overall, this discussion demonstrates that the practical application of BI, as evidenced by the development and deployment of the BI dashboard at Redmond Farm Kitchen, not only meets but expands upon the discussions in the academic literature. We hope it offers a compelling case study on the effective use of BI tools in the restaurant industry, providing valuable insights for future research and practice in this rapidly evolving field.

# 5. Conclusions, Limitations, and Recommendations

This master's thesis attempts to address a critical disconnect in the restaurant industry: the abundant availability of BI systems and their surprisingly limited practical application. The project aimed to develop a real-time BI dashboard specifically tailored to the operational context of Redmond Farm Kitchen to improve staffing efficiency and operational cost management. The journey from conceptualization to implementation has provided valuable insights and highlighted several learning opportunities, paving the way for potential future advancements.

This chapter synthesizes the main findings, acknowledges the limitations, and offers recommendations for future work. It provides an overview of the project outcomes and explores areas for further development to enhance the effectiveness of BI tools in restaurant operations. By addressing the challenges encountered and proposing future enhancements, this chapter aims to guide the continued evolution of BI systems, ensuring they remain valuable assets in optimizing operational efficiency and resource management in the restaurant industry.

## 5.1. Summary of Work and Main Findings

The primary objective of this project was to design and implement a user-friendly real-time BI dashboard for Redmond Farm Kitchen. The dashboard aimed to bridge the gap between theoretical BI capabilities and their practical deployment, focusing on enhancing staffing efficiency and cost management. Python integration within Power BI and API data connections were chosen for this project due to their relative ease of use and replicability, allowing for the seamless operation of the dashboard and facilitating real-time data analysis and actionable insights.

The implementation of the dashboard had a significant business impact, particularly in the dynamic management of staffing levels based on real-time revenue. By analyzing customer traffic patterns and sales data, the restaurant could accurately predict peak times and adjust staffing schedules accordingly. This led to reduced overstaffing and understaffing, ensuring the right number of staff members were on duty at different times of the day, minimizing idle time and reducing labor costs. With appropriate staffing levels, the restaurant was better equipped to deliver high service standards, potentially reducing wait times and enhancing operational efficiency.

Real-time insights into sales trends enabled better inventory control, reducing waste, and ensuring the availability of high-demand items. The dashboard facilitated inventory forecasting by analyzing sales data, allowing the restaurant to predict which items would be in demand and adjust orders and stock levels to match. This precise forecasting minimized the likelihood of overordering perishable items, which in turn can minimize food wastage.

By analyzing customer traffic in real-time, the restaurant was able to better align resources with demand, enhancing overall operational efficiency. Real-time data allowed for the efficient allocation of resources, ensuring that all operational areas were adequately supported during peak times.

Additionally, the dashboard's user-centric design, developed through iterative feedback from operational managers, ensured its functionality met the practical needs of the restaurant. The ETL processes, designed to capture both real-time and historical data, facilitated a comprehensive analysis that supported both immediate operational adjustments and long-term strategic planning.

The project also included a survey of operational managers, which highlighted high satisfaction levels with the dashboard's ease of use, performance, relevance, and visual design.

Suggestions for improvements, such as closer positioning of related metrics and the inclusion of seasonal trends and customer experience metrics, were gathered for future enhancements.

## 5.2. Limitations

The project was guided by the Kimball Lifecycle methodology, chosen for its structured, iterative approach which was well-suited to the project's scale. However, the focus on a single methodology meant that other potentially valuable methodologies were not explored. While the Kimball Lifecycle provided a strong foundation, future projects could benefit from researching and potentially integrating alternative approaches.

The dashboard's user-centric design was developed through iterative feedback from operational managers, ensuring its functionality met practical needs. However, more time could have been dedicated to understanding cognitive load and UX principles to further enhance the user experience. Ensuring the dashboard was intuitive and user-friendly posed significant challenges. Balancing the amount of information presented without overwhelming users was a key concern, and staff members required training to effectively use the dashboard, highlighting the need for ongoing support and education.

Data integration proved technically challenging, as it involved ensuring consistency and handling large volumes of real-time data. The project relied heavily on data from the Cloud Retailer POS system, but incorporating other datasets from different sources could have provided a more comprehensive picture of the restaurant's operations.

One limitation was the project's focus on a single restaurant, which limits the generalizability of the findings. The specific operational practices and customer base of Redmond Farm Kitchen may not be representative of other restaurants. Additionally, the dashboard primarily addressed operational metrics and did not provide a holistic view of the restaurant's performance. No explicit measures of labor costs were included due to not having access to the time management system.

Furthermore, the use of predictive analytics in this project was basic. There is significant potential to enhance the dashboard's capabilities with more advanced predictive analytics, providing deeper insights and more powerful forecasting tools.

## 5.3. Future Work

To build on the success of this project, future work should focus on several key areas to address the limitations identified and further enhance the effectiveness of BI tools in restaurant operations.

- **Advanced Predictive Analytics:** Integrate more sophisticated predictive analytics to enhance forecasting accuracy, aiding in more precise staffing and resource management. Future enhancements could include machine learning algorithms to predict customer traffic patterns, sales trends, and inventory needs with higher accuracy. Additionally, developing tools to simulate different operational scenarios and their potential impacts on staffing and inventory would enable proactive decision-making.
- **Expansion to Other Settings:** Validate the dashboard's scalability and effectiveness by extending the study to other restaurants or industries. Conducting pilot studies in different types of restaurants and food service settings to test the dashboard's adaptability is essential. Moreover, exploring the applicability of the dashboard in other industries with similar operational challenges, such as retail or hospitality, could provide valuable insights.

- **Enhanced Data Integration Techniques:** Explore advanced data integration methods to handle larger and more complex datasets, ensuring the dashboard remains robust and efficient. Future work might focus on leveraging cloud computing solutions to enhance data processing capabilities and storage. Implementing advanced data streaming technologies to ensure continuous, real-time data updates without latency issues is also crucial.
- **Business Unit Integration:** Expand the dashboard's scope to encompass the entire business unit, not just the restaurant, providing a comprehensive overview of operational efficiency. This could include developing dashboards for other departments within Redmond Farm Kitchen, such as production, distribution, and retail. Creating a centralized data platform that integrates information from all business units would enable holistic analysis and decision-making.
- **Continuous Efficiency Assessment:** Implement a framework for ongoing assessment of the dashboard's efficiency and effectiveness, incorporating user feedback and technological advancements. Key components might include establishing a system for regular user feedback to identify areas for improvement and developing KPIs to continually monitor and evaluate the dashboard’s impact on operational efficiency.
- **Methodological Exploration:** While the Kimball Lifecycle provided a strong foundation, exploring other methodologies could provide additional insights and potentially more effective approaches for BI system implementation. Future projects should consider a comparative analysis of different methodologies to identify the most suitable frameworks for specific contexts.
- **Enhanced User Experience Design:** More time could be dedicated to understanding cognitive load and UX principles to further enhance the user experience. Future iterations of the dashboard should incorporate comprehensive user experience research to ensure the interface is as intuitive and user-friendly as possible.
- **Incorporating Additional Datasets:** To create a more comprehensive picture of the restaurant's operations, future work should consider integrating additional datasets beyond the Cloud Retailer POS system. This could include data from the time management system, google reviews, and other relevant sources.

## 5.4. Concluding Remarks

The development and implementation of the real-time BI dashboard at Redmond Farm Kitchen highlights the transformative potential of BI tools in enhancing operational efficiency. This project serves as a model for how restaurants can leverage real-time data to make informed decisions, optimize resources, and improve overall service quality. The insights gained from this project encourage future advancements in the use of BI tools across the restaurant industry, pointing to significant improvements in operational management and customer satisfaction.

By addressing the limitations and exploring future directions, the project sets the stage for ongoing innovation and improvement in the deployment of BI systems. The demonstrated benefits and practical applications of real-time BI tools underscore their value in driving efficiency and excellence in the restaurant industry and beyond.

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