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A Process Mining Framework for Addressing Challenges of Marketing Research

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Abstract

In today's fast-paced business environment, marketing research is vital for companies seeking to succeed. By systematically collecting and analyzing customer preferences, market trends, and competitive dynamics, companies can make informed decisions related to customer needs and expectations [18]. Companies that prioritize marketing research are better able to understand market conditions, reduce associated risks, successfully launch, and ultimately achieve sustainable growth. Process mining is a data-driven approach that combines model-based process analysis with data-oriented analysis techniques. It provides deep insights into processes and an understanding of how to improve them. This research applies a data mining framework for marketing research, enabling companies to identify new opportunities, refine their marketing strategies, and enhance product offerings, leading to increased customer satisfaction and loyalty. This research, through a science approach, proposes a framework for applying process mining to the marketing research process. This study represents a step toward gaining a better understanding of the real-world marketing research process.

Keywords: Scientific Workflows, Marketing Research, Process Mining, Market Trend, Customer Satisfaction.

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Introduction

Marketing research is one essential process of each business and provides managers with valuable information. Managers' perspectives on the importance of marketing research have evolved from viewing it as a supplementary activity to recognizing it as a core component of strategic decision-making [7]. Today, managers understand that effective marketing research is vital for navigating complex market environments, enhancing customer satisfaction, and achieving competitive advantage [1]. Understanding consumer needs, behaviors, and motivations is crucial for developing products and services [13]. Marketing research helps uncover these issues through various techniques, such as surveys and focus groups. Launching new products or entering new markets involves significant risks. Marketing research helps mitigate these risks by providing data-driven insights that inform managers to make appropriate strategic decisions, such as product features, pricing, and market entry strategies [16, 1]. By identifying distinct groups within a market based on demographics, behaviors, and preferences, companies can create tailored marketing strategies. Effective segmentation allows companies more precise targeting and improves marketing efficiency [10]. Furthermore, marketing research provides businesses with their competitors' strengths and weaknesses, enabling them to identify opportunities for differentiation and find their market position. Continuous marketing research allows companies to assess the effectiveness of their marketing efforts and measure customer satisfaction, brand perception, and campaign performance [19].

Marketing research includes key parts as follows:

Problem Definition: The specific issue or opportunity that the research aims to address should be identified.

Research Design: The structure of conducting research should be determined, including selecting methods for data collection (qualitative or quantitative).

Data Collection: Gathering information is a sensitive step done through surveys, interviews, focus groups, observations, or secondary data sources.

Data Analysis: Interpreting the collected data to extract meaningful results.

Reporting and Presentation: Presenting the findings to stakeholders in a clear and actionable manner.

Due to technological advancements and changing consumer behaviors, the methods and tools for conducting marketing research have evolved significantly over the years. A comprehensive comparison of marketing research methods in the past and present is explained in Table 1.

Table 1. Comparison of Marketing Research Methods in the Past and Present

Data Collection	Past Methods	Present Methods
Surveys	- Primarily conducted via paper questionnaires and mail. - Response rates were often low, and collection was time-consuming.	- Conducted online through platforms like Google Forms. - Instant feedback and higher response rates due to accessibility.
Interviews	- Face-to-face interviews were common. - Limited geographic access.	- Virtual interviews via video conferencing tools (e.g., Zoom, Skype) allow for broader participation. - More efficient scheduling and reduced travel costs.
Focus Groups	- Small groups for discussion.	- Online focus groups and discussion panels enable participation from diverse locations.
Observational Research	- Direct observation in real-world environments (e.g., stores) was labor-intensive.	- Use of digital analytics (e.g., website behavior and social media interactions) allows for continuous monitoring.

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	- Limited to specific timeframes and locations.	- Remote observation through tools like eye tracking and heat maps.
Secondary Research	- Relied on printed reports, industry publications, and libraries. - Time-consuming to gather and analyze existing data.	- Access to vast online databases, academic journals, and market reports. - Tools like Google Scholar facilitate quick searches for relevant studies.
Sampling Techniques	- Random and classified sampling often involved manual processes.	- Advanced sampling techniques can be automated through online tools.
Data Analysis	- Manual data analysis, often leading to potential errors. - Basic statistical methods were common.	- Advanced analytics tools (e.g., SPSS, R, Python) enable complex data analysis, including predictive analytics and sentiment analysis. - Real-time data visualization tools (e.g., Tableau) enhance understanding of trends.
Cost	- Higher costs due to travel, facilities, and personnel for in-person reseach.	- Reduced costs due to online tools, automation, and remote data collection methods.
Speed	- Data collection and analysis could take weeks or months.	- Instant data collection and analysis, allowing for quicker decision-making.
Consumer Engagement	- Limited interaction	- Interactive surveys and feedback mechanisms (e.g., polls on social media) engage consumers.
Flexibility	- Rigid research designs; difficult to adapt once the study began.	- Agile methodologies allow for adjustments based on preliminary findings. - Continuous research frameworks enable ongoing consumer insights.

The evolution of marketing research methods has reflected a significant shift toward efficiency, accessibility, and data-driven decision-making. Modern marketing research leverages technology to gather and analyze data more effectively and provide companies with timely insights that are essential for navigating.

Conducting marketing research is accompanied by several challenges that can complicate the process and affect its outcomes. One major challenge is the ever-changing nature of consumer behavior and market dynamics, which can make it difficult to gather relevant and timely data. Additionally, budget constraints often limit the scope of research, leading to a decrease in the quality and comprehensiveness of research. Accessing accurate data can also be problematic, especially in industries with limited availability of reliable sources or when dealing with sensitive information [8]. Finally, interpreting complex data into actionable insights requires expertise and can be time-consuming. As a consequence, managers seek to apply a scientific approach to address these challenges. There are numerous papers suggesting various methods to enhance the quality of marketing research.

An in-depth overview of the tactical and strategic issues concerning internal marketing was elucidated in [27]. It presents a resulting model and discusses various research challenges in the interdisciplinary field of internal marketing. In [9], authors delve into the significance of theoretical frameworks in marketing research. This paper argues that theory guides empirical research, helps in the formulation of hypotheses, provides a structure for understanding marketing phenomena, and enhances the rigor and relevance of research findings.[6] discusses the evolution of ethics in international marketing and also reviews the research background and identifies the challenges that arise in the context of ethical practices in international marketing.

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Authors of [28] discuss how functional magnetic resonance imaging (FMRI) can be leveraged in marketing research. They highlight both the potential benefits of using fMRI to understand consumer behavior and the challenges that researchers may face, such as practical implementation and interpretation of data.

The book [12] offers a comprehensive overview of marketing research methodologies, emphasizing a scientific approach to data collection, analysis, and interpretation. It addresses various challenges faced in marketing research and offers practical solutions. This paper [26] surveys the current state of niche marketing research. It aims to identify challenges within the field and lay the groundwork for future academic inquiry. The following can be mentioned in other researches: Taghipour et al. [20] studied Necessity Analysis and Optimization of Implementing Projects with The Integration Approach of Risk Management and Value Engineering. Taghipour et al. [21] studied Assessment of the Relationship Between Knowledge Managment Implementation and Managers Skills (Case Study: Reezmoj System Company in Iran). Taghipour et al. [22] studied Study of the Application of Risk Management in the Operation and Maintenance of Power Plant Projects. Taghipour et al. [23] studied "Evaluation of the Relationship between Occupational Accidents and Usage of Personal Protective Equipment in an Auto Making Unit. Taghipour et al. [24] studied "The impact of ICT on knowledge sharing obstacles in knowledge management process (including case-study). Taghipour et al. [25] studied The impact of working capital management on the performance of firms listed in Tehran Stock Exchange (TSE). Khodakhah Jeddi et al. [11] studied The Analysis of Effect Colour Psychology on Environmental Graphic in Childeren Ward at Medical Centers. This paper [5] explores loyalty programs (LPs) and their role in fostering customer relationships. It discusses current insights, research challenges, and emerging trends related to these programs. LPs provide benefits to customers, such as monetary incentives, to encourage repeat business and loyalty. The application of sentiment analysis within the marketing sector is explored in [17]. It critically analyzes existing marketing literature to understand how sentiment analysis can be utilized to gauge consumer opinions and improve marketing strategies. This review also highlights methodological approaches and future research directions in this area. The rapid evolution of the role of marketing, accompanied by changes in design and analysis methods employed in marketing research, is discussed in [8]. The author focuses on the new opportunities and challenges faced by researchers in adapting to these changes.

Process mining can significantly enhance the effectiveness of marketing research by addressing several inherent challenges. First, it provides a data-driven approach that enables businesses to analyze customer interactions and behaviors in real-time, thus adapting to changing consumer preferences more swiftly. By utilizing advanced algorithms to extract insights from large data sets, process mining can alleviate budget constraints by optimizing research processes and reducing the need for extensive manual data collection. Furthermore, it improves data access by integrating information from various sources, ensuring a more comprehensive view of the market landscape. In terms of biases, automated data collection methods reduce human error and subjective influences, leading to more accurate findings. Finally, process mining simplifies the complexities of data analysis by visualizing workflows and highlighting trends, allowing marketers to interpret data more intuitively and make informed decisions quickly. Overall, process mining streamlines the marketing research process, providing valuable insights that enhance decision-making and strategic planning [14]. This research aims to develop a process mining framework as a scientific approach to addressing marketing research challenges. It relies on the design science research methodology (DSRM) with six steps [15].

The structure of the current research is as follows. In Section 2, the method of this paper is presented. This section includes the six-step framework based on design science research methodology (DSRM) and applies the refined scientific workflow notation for marketing research. Finally, Section 3 presents the research results.

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Materials and Methods

This section explains six steps of the design science research methodology (DSRM) to deal with the marketing research challenges [3, 15] and applies process mining workflow for the identified marketing research challenges.

Problem Identification and Motivation

The data used in this study were collected from twenty companies across various fields of activity, and the selection of companies was conducted using simple random sampling.
The data were gathered in two ways:

- Interviews with marketing and strategic managers
- The results of the studies that focused on marketing research challenges.

After classifying and grouping challenges to remove redundancy, six challenges were considered as common marketing research challenges.

Define the objective of a solution

The presented framework aims to systematically apply process mining workflow to address the identified marketing research challenges.

Design and development

This section includes two steps: refinement of the scientific workflow notation [4] to incorporate specific marketing research characteristics. Then, the application of the process mining framework for the most important challenges identified in selected companies.

Refinement of the Scientific Workflow

The original scientific workflow for process mining is composed of three concepts: building blocks, inputs, and outputs.

Building block

The process-mining building block represents the logical unit of work needed to process the inputs and generate the outputs. Every process-mining building block generates distinct outputs after receiving several inputs. The input parts represent the set (or sets) of abstract objects needed to function. To produce process-mining scientific workflows, the process-mining building blocks can be linked together to address a variety of process-mining questions [4].

The Inputs and Outputs

The inputs and outputs are as follows [4]:

- **Information systems:** They support the performance of processes at runtime. They are represented by the label “S”.
- **Event data sets:** They contain the recording of the execution of process instances within the information system(s), regardless of the format. They are represented by the letter “E” and divided into two groups: E_C for current events and E_H for historic events. The de facto standard format to store events is currently XES.
- **Additional Data Sets:** They can be used as input for certain process-mining building blocks and are represented by the letter “D”.
- **Process models:** They are a representation of the behavior of a process and are represented by the letter “M”.
- **Sets of parameters:** They configure the application of process-mining building blocks (e.g., thresholds, weights, ratios, etc.) and are represented by the letter “P”.
- **Results:** They are outputs of a process-mining building block. Results are represented by the letter “R”.

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The result of the refinement framework for marketing research (inputs, outputs) is as follows:

Information System (S)

- This part refers to the system that collects, stores, processes, and analyzes data from activities related to marketing.
- The information system for marketing research includes various tools that manage data related to customer behavior, competitor analysis, sales statistics, surveys, and market information.
- **For example,** Customer Relationship Management (CRM) systems, Google Analytics, social media platforms, and market surveys.

Event Data Set (E)

- The recorded data from various marketing events.
- These data could include customer interactions with the brand, purchase times, customer satisfaction levels, demand fluctuations, and consumer behavior.
- **For example**, customer purchase history, customer participation in advertising campaigns, website usage data, customer engagements in social media posts (likes, shares, comments), and results of A/B testing campaigns.

Additional Data Set (D)

Complementary data that enriches the event data set. This can include demographic information, market trends, external industry data, or other relevant datasets that help contextualize or augment the primary data.

Process Model (M)

- This part refers to how the marketing research is conducted, which includes data collection, data cleaning, exploratory analysis, modeling, decision-making, and representation.
- The “De jure” marketing research process model (MJ) is the expected behavior of a marketing research process. It is the BPMN created by managers.
- The “De facto” marketing research process model (MF) is the actual behavior of a marketing process. It is the BPMN discovered by a process discovery algorithm.
- These processes could be depicted graphically or modeled using languages like BPMN (Business Process Model and Notation).

Set of Parameters (P)

- This section defines the various parameters that control the process or are analyzed as part of the workflow.
- These parameters could include factors such as minimum acceptable ROI, desired percentage of user interactions, conversion rate, advertising costs, customer demographics, customer satisfaction levels, campaign duration, and many other variables.

Result (R)

- The result is the final output that is obtained after processing and analyzing the data in the model.
- Results could include reports such as sales trend forecasts, ROI analysis of advertising campaigns, identification of key customers, recommendations for improving marketing strategies, customer preference analysis, purchase trend forecasting, market gap analysis, consumer choice modeling, recommendations for budget reallocation across campaigns, and other parameters.

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- Results can be qualitative or quantitative and presented either numerically (e.g., forecasting sales for the next month) or graphically (e.g., charts analyzing customer behavior).

Application of Process Mining Workflow

This section provides the identified challenges of marketing research along the four steps of the performance management cycle [2]. For each challenge, a process mining scenario has been developed using the scientific workflow notation. Due to space limitations, only the relevant building blocks for these scenarios are outlined.

Challenges in Marketing Research

1. **Data Overload:**
   Marketing generates vast amounts of data from diverse sources like social media, CRM systems, websites, and surveys. Analyzing and synthesizing this data efficiently is difficult.
2. **Data Quality and Inconsistencies:**
   Missing, duplicate, or inconsistent data can distort insights. This is common when data is collected from multiple systems.
3. **Dynamic Customer Behavior:**
   Rapid changes in customer preferences and behaviors make it challenging to keep insights relevant and actionable.
4. **Attribution Challenges:**
   Determining the impact of specific marketing activities across multiple interaction points with customers is complex, especially in omnichannel environments.
5. **Integration Across Systems:**
   Combining data from disparate sources like sales, marketing campaigns, and customer service into a cohesive analysis is often cumbersome.
6. **Timeliness of Insights:**
   Decision-making requires insights to be delivered in real-time or near real-time, but traditional methods often lag.

Process Mining Scenarios (Relevant Building Blocks)

Process mining can address these challenges using its core building blocks to enhance marketing research workflows.

1. **Event data extraction (import event data):**
   - Process mining starts by extracting event data from information systems (e.g., CRM, ERP, or digital analytics tools).
   - **Challenge Addressed:** It provides a unified structure for handling data overload and ensuring consistency.
2. **Process model and event analysis (evaluate process model using event data)**
   - Compares the discovered process model with predefined marketing strategies to identify deviations.
   - **Challenge Addressed:** It helps ensure data quality and alignment with expected workflows, reducing inconsistencies.
3. **Process model extraction (discover process model from event data):**
   - Visualizes the actual workflows (e.g., customer journeys or campaign execution flows) by analyzing event logs.
   - **Challenge Addressed:** It reveals hidden patterns in customer behavior, helping to track dynamic changes and interactions.
4. **Process model and event analysis (generate report)**
   - Process mining can integrate with predictive analytics tools to forecast customer behavior or campaign performance.

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- **Challenge Addressed:** It provides proactive insights, helping marketers anticipate future trends and behaviors.

5. **Process model enhancement (enrich process model using event data)**

- Enriches process models with additional data (e.g., customer demographics and market trends) to provide deeper insights.
- **Challenge Addressed:** It integrates diverse datasets, addressing integration issues and providing practical insights.

6. **Process model and event analysis (analyze event data)**

- Measures key performance indicators (KPIs) like conversion rates and campaign throughput times.
- **Challenge Addressed:** It supports real-time insights for decision-making and tracks the impact of marketing activities.

Example Process Mining Scenario

Challenge: Understanding the impact of a marketing strategy.

Process Mining Approach

Input: Extract event logs from the information system through various sources (e.g., website visits, email clicks, in-store transactions).

1. Use process discovery to visualize the customer journey across channels.
2. Apply conformance checking to compare actual customer journeys against intended strategies.
3. Perform performance analysis to identify bottlenecks or low-performing channels.
4. Enhance the analysis by adding demographic and transactional data.

Output: Insights into customer preferences, channel effectiveness, and optimization opportunities for the strategy.

Demonstration

The identified challenges were analyzed successfully.

Evaluation

The current research activities focus on the evaluation of the framework with company real data, but it is out of the scope of this research.

Communication

This research is part of the communication activities and will be completed by a journal paper that evaluates this framework.

Conclusion

Market research plays an important role in a company's strategic plan and serves as a guiding compass in a dynamic and competitive business environment. Market research provides valuable information about consumer behavior, market trends, and competitive strategies, allowing companies to make decisions that are compatible with customer needs and desires. By conducting effective marketing research, companies can identify new opportunities, mitigate risks, and ultimately drive growth and profitability. This process involves many complex steps, such as defining research objectives and designing methodology for collecting and analyzing data. Companies must address the challenges of data quality, pattern identification, and interpretation of results to make meaningful and actionable decisions. Furthermore, with the rapid advancement of technology and the growing complexity of companies, they require advanced analytical tools and methods to extract valuable insights from various sources of data. The scientific workflow notation offers a structured approach to tackling the challenges of marketing research by providing a systematic methodology for analyzing and optimizing business processes. Process mining

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techniques in marketing research can provide valuable insights into marketing strategies, identify bottlenecks, streamline processes, and improve decision-making. This visualization and analysis can optimize campaigns, enhance customer targeting, and drive business performance. This research applied the scientific workflow notation for the most important challenges of marketing research found in the twenty companies.

Author contributions

Conceptualization, FE and MT; methodology, FE and MT; software, MT and FE; validation, FE and MT; formal analysis, FE and MT; investigation, MT and FE; resources, EB and MT; data curation, EB and MT; writing—original draft preparation, FE and MT; writing—review and editing, MT and FE; visualization, MT and FE; supervision, FE and MT; project administration, FE and MT. All authors have read and agreed to the published version of the manuscript.

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