DIGITAL TRANSFORMATION AND ADMINISTRATION INNOVATION

Citation: Khashei Varnamkhasti, V., Ebrahimi, M., Zare, R., & Kashani, F. (2025). Evaluation of Competitive Intelligence Using a Machine Learning Approach in the Insurance Industry. *Digital Transformation and Administration Innovation*, 3(2), 1-11.

Received: date: 2025-01-20 Revised: date: 2025-04-11 Accepted: date: 2025-05-12 Published: date: 2025-06-30

Evaluation of Competitive Intelligence Using a Machine Learning Approach in the Insurance Industry

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Abstract

This systematic review article examines the role of competitive intelligence and machine learning in the insurance industry. Given the rapid advancements in information technology and the increasing need for accurate strategic decision-making in the face of intensifying competition, competitive intelligence has emerged as a vital tool for data analysis and predicting competitor behavior in this sector. This study analyzes various methods of applying machine learning to process both structured and unstructured data within the insurance industry and explores the associated challenges and opportunities. The article first analyzes the fundamental concepts of competitive intelligence and developments in information technology in this domain. It then investigates the challenges and requirements of the insurance industry in utilizing advanced data analytics techniques, including machine learning. The findings indicate that integrating machine learning with competitive intelligence can assist insurance companies in conducting large-scale data analysis, thereby enabling more accurate predictions of competitor behavior and market trends. Moreover, the article identifies existing research gaps and presents a conceptual model for the application of competitive intelligence in the insurance industry, offering recommendations for future research and practical applications for insurance industry managers.

Keywords: Competitive Intelligence, Machine Learning, Insurance Industry

1. Introduction

With the rapid advancement of information technology and ongoing environmental transformations, organizational adaptability to new conditions has become a critical necessity. This need is even more pronounced for large organizations, given the breadth of their decision-making domains. The necessity arises from the significant increase in the number of organizational decisions due to the growing complexity of the business environment, the need for more accurate and up-to-date information for effective decision-making, and the entry of traditional organizations into the realm of information technology, compelling them to align their programs and strategies with this new landscape (Averch, 1990).

The intensifying competition in the insurance industry has driven managers in this field to seek strategies to maintain their presence. Beyond efforts to increase policy sales, goals such as cost reduction and enhancing the corporate image to achieve competitive advantage are among the priorities pursued by these managers (Maluleka & Chummun, 2023). In order to deliver

greater value and gain customer satisfaction across all areas, companies require comprehensive information. This information includes data related to competitors, intermediaries, and other influential market factors. Information is regarded as one of the most important strategic assets and marketing tools. The collection and analysis of competitor-related data plays a vital role in formulating effective strategies. The more information a company possesses about its competitors, the more likely it is to succeed in developing and implementing appropriate strategies. Consequently, monitoring, understanding, and responding to competitors are considered crucial components of marketing activities (Rezaeian & Lashkarbolouki, 2010).

In today's world, the speed of decision-making in response to environmental threats and opportunities plays a critical role in organizational success. Traditional analyses are often time-consuming and inadequate in addressing the needs of contemporary organizations. Dynamic analyses assist organizations in continuously monitoring the environment and promptly identifying changes to respond effectively to threats and opportunities. These analyses, by providing accurate and real-time information, create the foundation for rapid and effective decision-making. Studies indicate that 80% of the information required for intelligent analysis is unstructured, while 20% is structured (Muritala & Ajetunmobi, 2019; Muritala et al., 2019). Structured data is extracted from organizational databases and information systems, whereas unstructured data is obtained from various sources such as paper documents, electronic content, audio-visual materials, and individuals' knowledge inside and outside the organization.

Given the vast volume of available structured and unstructured data, traditional tools are inefficient in processing and analyzing this data. Conventional methods fall short in uncovering hidden insights. In this regard, the application of machine learning techniques and big data analytics can help insurance companies make better use of their data and achieve improved strategic decision-making. Previously, one of the main limitations of business intelligence tools was their inefficiency in uncovering hidden insights. By employing intelligent systems, it becomes possible to extract various trends from existing data, enabling insurance industry managers to make strategic decisions and plan for the future. This capability allows managers to more accurately monitor and quickly analyze the business environment, leading to better decisions (Wanke & Barros, 2016).

Thus, the primary challenges faced by insurance companies include rapid changes, continuous transformations, complexity in the business environment, advancements in information technology, the massive volume of unstructured data, the inefficiency of existing tools in uncovering hidden insights, the need for reliable tools, fast decision-making, accurate forecasting of future trends, and intensifying competition among firms. Under these conditions, intelligent and dynamic analyses can support organizations in promptly responding to environmental threats and opportunities and enhancing strategic decision-making. Companies must obtain reliable data on market indicators to effectively confront the competitive challenges of today's business world. Therefore, an effective competitive intelligence system is an essential requirement for achieving competitive advantage goals, as outlined in company missions and visions.

Despite the recognized importance of competitive intelligence as a driver of competitive advantage, there is a limited number of studies that examine the various practical aspects of competitive intelligence that influence company advantage. The following figure illustrates the conceptual framework of the interaction between competitive intelligence and competitive advantage (Jasim et al., 2020).

This systematic review article investigates the role of competitive intelligence and machine learning in the insurance industry. It begins by analyzing the fundamental concepts of competitive intelligence and developments in information technology in this field and examines the challenges faced by the insurance industry in the digital age. Subsequently, the review methodology is presented through the definition of inclusion criteria and screening of studies, followed by the analysis and synthesis of research findings and the conceptual research framework. The key findings are then discussed, including the identification of research gaps, the presentation of a conceptual model of competitive intelligence, and the evaluation of the benefits and limitations of machine learning-based solutions in the insurance industry. Finally, the article concludes with a summary of the systematic findings, practical recommendations for insurance industry managers, and suggestions for future research. Through a critical analysis of existing literature, this study contributes to a deeper understanding of the applications of competitive intelligence in the insurance sector and paves the way for future investigations in this area.

2. Theoretical Foundations

2.1. Competitive Intelligence

Competitive intelligence pertains to competitors, their capabilities, activities, and plans. It is employed by strategic operations that are part of the organization's strategic division. It is also utilized by professionals responsible for innovation, such as research and development managers, who focus on developing new products, services, processes, and business models. This form of intelligence analyzes both current and potential data and information (McGonagle & Vella, 2012).

The objective of the competitive intelligence approach is to enable decision-makers and business strategists to develop appropriate strategies in response to competitor strategies, allowing the business to attain a competitive advantage. This approach emphasizes the interaction and interdependence between a business and its competitor(s). In this context, the outcomes achieved by businesses in a competitive environment depend not only on their own decisions and strategies but also on those of their competitors. Due to this interdependence, a strategic assessment process—one that simultaneously analyzes the strategies of both the business and its competitors—must be conducted to enable proper planning and decision-making. Strategy and competitive intelligence are inextricably linked. Competitive intelligence is not only an activity or set of activities within a broader strategic management process, but also a crucial strategic function (Maritz & Du Toit, 2018).

The information and data provided throughout the competitive intelligence process transform it into an essential component of strategy formulation and implementation. Herring (1992) outlined six distinct roles of competitive intelligence in the development and execution of successful strategies: (1) defining the competitive environment, (2) forecasting the future competitive environment, (3) testing assumptions by asking the right questions, (4) identifying and eliminating weaknesses, (5) implementing or modifying strategies to reshape the competitive environment, and (6) determining the timeliness of these strategies. Furthermore, competitive intelligence should encompass evaluations of both the current and potential future competitive environments of the firm.

To perform these functions effectively, a business must first define its goals regarding competitive intelligence. Subsequently, the information gathered in alignment with these goals becomes a fundamental tool for strategy-related decision-making (Gaspareniene et al., 2013).

The effective execution of the competitive intelligence process depends on the quantity and quality of the information provided. An efficient competitive intelligence process requires the collection of four interrelated types of information that comprehensively describe the business environment in which the company operates. These are: (1) information about competitors, (2) comparative information that highlights differences among various competitors, (3) market-related information including customers, suppliers, distribution channels, and technology, and (4) information about the business itself (Weiss, 2002).

Competitive intelligence, as one of the key tools in the strategic planning process, plays a fundamental role in business decision-making. It refers to a set of activities and processes through which external and internal information about an organization is collected, analyzed, and interpreted to help decision-makers adopt optimal business strategies. In general, competitive intelligence encompasses the collection and analysis of data related to competitors, technologies, and economic, social, political, and environmental conditions that affect the organization and its rivals.

Within this framework, competitive intelligence has typically been studied through four different approaches: conceptual, product-based, professional, and systemic.

1. **Conceptual Approach**: In this perspective, researchers examine and describe the concepts, variables, and processes related to competitive intelligence, aiming to understand its various dimensions. This approach focuses on the fundamental and theoretical aspects of competitive intelligence (Babaimehr & Zingir, 2016; Fourati-Jamoussi et al., 2018).
2. **Product-Based Approach**: This approach emphasizes the development of methods and techniques for generating practical outputs of competitive intelligence. It refers more to the practical applications and utilization of collected data in strategic decision-making (Abdellaoui & Nader, 2015; Chakraborti & Dey, 2016).
3. **Professional Approach**: This view considers competitive intelligence as a profession with specific principles and ethical codes, emphasizing that data gathering and analysis must comply with professional standards (Köseoglu et al., 2020).

4. **Systemic Approach**: In this perspective, competitive intelligence is regarded as a decision-support system for organizations. It stresses the importance of establishing systems capable of continuously collecting and analyzing competitive data to assist managers in making more intelligent decisions (Calof, 2017; García & Esteban, 2020).

Beyond these conceptual approaches, several implementation methods for competitive intelligence have also been developed, which facilitate data analysis and market trend simulation. These methods include the use of semantic data warehouses and big data, data mining and text mining, as well as web and social media analytics, enabling businesses to simulate market trends and behaviors more accurately.

Competitive intelligence and strategic thinking are also closely intertwined. Strategic thinking enables managers to analyze and predict competitive positions using competitive information and to formulate effective, long-term strategies. This type of thinking relies on foresight analyses to anticipate market shifts and competitor movements. In this regard, competitive intelligence directly supports the strategy formulation process. This connection is particularly critical in complex competitive conditions and rapidly changing markets, where flexibility and clarity in decision-making are essential.

Hence, organizations must be capable of utilizing available data and information in the competitive ecosystem to analyze trends and forecast future scenarios in order to protect their competitive advantage.

2.2. Machine Learning

Machine learning has evolved from the study of computational learning theory and pattern recognition. It is one of the most effective approaches in the field of data analysis, primarily used for prediction through the development of models and algorithms. These analytical models enable researchers, engineers, data scientists, and analysts to produce reliable and valid results and decisions. It also facilitates the discovery of hidden patterns or features through historical learning and data trends. Feature selection is the most critical task in machine learning. The model is built based on data collected from training sets, making machine learning algorithms non-interactive. They study past observations to make accurate predictions. Creating a precise predictive rule upon which an algorithm can be developed is a highly challenging task.

Machine learning (ML) algorithms can generally be categorized into three main types:

1. **Supervised Learning**: In supervised learning, ML algorithms are trained on labeled data, where input data is associated with corresponding output or target labels. The algorithm learns to map the input data to the desired output by identifying patterns and relationships in the training data. After training, the model can make predictions or classify new and unseen data based on learned patterns.
2. **Unsupervised Learning**: Unsupervised learning involves training ML algorithms on unlabeled data, where the goal is to discover patterns, structures, or relationships within the data without predefined labels. Common tasks in unsupervised learning include clustering, dimensionality reduction, and anomaly detection. The algorithm learns to identify similarities, group data points, or detect outliers based on inherent patterns in the data.

As predictive techniques become more complex, insurers must navigate a complicated regulatory landscape that governs data usage and sharing. Ensuring compliance while maximizing the utility of data presents a critical challenge. The use of Privacy-Enhancing Technologies (PETs) can help insurers balance these requirements while facilitating effective data use in predictive modeling.

3. Review of Previous Studies

3.1. Studies on Competitive Intelligence in the Insurance Industry

3.1.1. Descriptive and Impact-Oriented Studies

Domestic Studies: Hamidzadeh et al. (2014), using a descriptive-exploratory method and collecting data from senior managers at Asia Insurance Company, proposed a dynamic competitive intelligence model aimed at achieving sustainable competitive advantage. This study identified and confirmed the factors influencing competitive intelligence in the insurance sector, showing that managers emphasize aspects such as staff training, communication skills, and loyalty to the company (Hamidizadeh et al., 2014).

Sepahvand et al. (2016) examined the impact of competitive intelligence on the organizational performance of insurance companies in Sanandaj. The findings indicated a significant and positive impact of competitive intelligence on organizational performance. The study suggested that customer information analysis can help identify needs and enhance the performance of insurance firms (Sepahvand et al., 2016).

Similarly, Tahmasebi Fard (2018) and Mohammadian et al. (2014) investigated the effect of competitive intelligence on market performance and competitive advantage in Iran's insurance industry (Mohamadian et al., 2014; Tahmasebifard, 2018). Vahdati et al. (2017) studied the impact of strategic intelligence on human, structural, and relational capital in the Khorramabad insurance business (Vahdati et al., 2017).

International Studies: Odiachi et al. (2021) examined the relationship between competitive intelligence and organizational sustainability in Nigeria's insurance sector (Odiachi et al., 2021). Oyomo (2019) analyzed the effects of customer orientation on competitive intelligence in Kenyan insurance companies (Oyomo, 2019). Muritala and Ajetunmobi (2019) investigated the relationship between competitive intelligence, competitive advantage, and employee productivity (Muritala & Ajetunmobi, 2019). Bitencourt Jorge et al. (2019) analyzed the effect of access-to-information laws on competitive intelligence in Brazil (Bitencourt Jorge et al., 2019).

Muñoz-Cañavate and Alves-Albero (2017) explored competitive intelligence practices in Spanish organizations, including insurance firms. They found that while competitive intelligence techniques were well established, they were often performed by departments other than information units. The study also showed that information units mostly delivered intelligence to management and interested product consumers, with most staff unaware of its critical importance (Muñoz-Cañavate & Alves-Albero, 2017).

Calof et al. (2018) reported that 87% of the studied organizations, including insurers, had formal competitive intelligence structures with information-related roles and used competitive intelligence for a wide range of strategic and tactical decisions (Calof, 2017).

Erikson and Rothberg (2012) examined how various industries, including U.S. insurance companies, balanced knowledge development and protection through competitive intelligence. Their findings indicated that competitive intelligence activity in the life insurance sector was aggressive and significant (Erickson & Rothberg, 2012).

Johns and Van Doren (2010) studied competitive intelligence in service marketing across various organizations, including insurance companies. The case study findings revealed that organizations engaged in competitive intelligence practices gained a competitive edge. Insurance companies also adapted their outlooks to integrate competitive intelligence into market research (Johns & Van Doren, 2010).

du Toit and Sewdass (2014) surveyed competitive intelligence experts in various organizations, including insurance firms, to assess the current state of competitive intelligence in Morocco. Their findings showed that most businesses, including those in insurance, used competitive intelligence as a strategic tool for environmental scanning (du Toit & Sewdass, 2014).

3.2. Review Studies and Identification of Research Gaps

Maluleka (2023), through a systematic literature review of competitive intelligence and insurance markets, highlighted the existing gap in integrating data analytics tools such as artificial intelligence and big data with competitive intelligence. The study showed a relatively higher focus of Iranian publications on competitive intelligence in insurance compared to those from other countries (Maluleka & Chummun, 2023).

Salimi Dangarlou (2015) categorized studies on competitive intelligence in Iranian organizations into two groups: "competitive intelligence related to marketing" and "competitive intelligence related to organizational performance." The findings indicated that competitive intelligence is recognized as a factor contributing to improved decision-making, company performance, entrepreneurship, and organizational agility (Salimi Dangharalu, 2015).

In the first category (competitive intelligence and marketing), studies by Rezaei Dolatabadi et al. (2011) and Pirayesh & Alipour (2012) explored the effect of competitive intelligence on competitive advantage, marketing strategies, and market performance (Pirayesh & Alipour, 2012; Rezaei Dolatabad et al., 2011).

In the second category (competitive intelligence and organizational performance), studies such as Vezifeh Doost & Ghasemi (2009) examined the effect of competitive intelligence on decision-making, company performance, entrepreneurship, and organizational agility (Vazifehdoust & Ghasemi, 2009).

3.3. Studies on Machine Learning in the Insurance Industry

3.3.1. Application of Machine Learning in Risk Assessment and Pricing

Kajouri Naftchali et al. (2023) developed a Risk Intelligent Model (RIM) based on artificial intelligence for engineering insurance risk assessment. By integrating data analysis, machine learning algorithms, and predictive modeling, the model offers a comprehensive risk perspective, going beyond traditional risk assessment approaches and incorporating a wide range of variables. Implementation of this model allows insurers to precisely identify threats and determine suitable strategies for their clients (Kajouri Naftchali et al., 2023).

Kaushik et al. (2022) utilized AI network regression to create a health insurance premium prediction model with an accuracy of 92.72%. Their research showed that machine learning can overcome the limitations of traditional actuarial methods and improve premium calculation accuracy (Kaushik et al., 2022).

Hartmann et al. (2020) and Cummings & Hartmann (2022) reviewed various machine learning models in the field of health insurance and long-term care. These studies demonstrated that ML algorithms can enhance the prediction of healthcare costs and optimize insurance coverage (Cummings & Hartman, 2022; Hartman et al., 2020).

Gan and Valdez (2024) investigated the use of exponential family principal component analysis for modeling mixed insurance data to improve predictive accuracy. The study indicated that these methods can reduce data dimensionality and increase the efficiency of predictive models (Gan & Valdez, 2024).

3.3.2. Application of Machine Learning in Claims Prediction and Fraud Detection

Shi et al. (2024) developed a model for improving insurance claims management by integrating dynamic weather data with deep learning techniques. Their study found that environmental data can increase the accuracy of damage-related predictions (Shi et al., 2024).

Masello et al. (2023) and Peiris et al. (2024) found that integrating telematics through ML models helps better understand risk characteristics. These studies showed that using sensor data and telematics systems can effectively assess driving behavior and predict accident probability (Masello et al., 2023; Peiris et al., 2024).

Charpentier et al. (2023) proposed a reinforcement learning technique and explored its application in the financial and insurance sectors. The study showed that reinforcement learning can be effective in optimizing financial decision-making and risk management in insurance (Charpentier et al., 2023).

Turcotte and Boucher (2024) developed a Generalized Additive Model for Location, Scale, and Shape (GAMLSS) to better understand longitudinal data in the insurance industry. This model helps analyze trends in insurance data over time (Turcotte & Boucher, 2024).

4. Comparative Analysis and Identification of Research Gaps

4.1. Existing Gaps in Competitive Intelligence Studies in the Insurance Industry

4.1.1. Traditional and Non-Systematic Approaches

A review of previous studies shows that most research on competitive intelligence (CI) in the insurance industry has adopted traditional approaches. For example, Hamidzadeh et al. (2014) and Sepahvand et al. (2016) used questionnaire-based methods

and basic statistical analyses to examine the state of CI (Hamidizadeh et al., 2014; Sepahvand et al., 2016). While these approaches provide valuable information on the overall status of CI, they have limited capacity to analyze the vast amount of unstructured data now available.

Additionally, studies such as Muñoz-Cañavate and Alves-Albero (2017) have shown that although insurance companies use CI techniques, these activities are often carried out by different departments and in a non-systematic manner. The lack of an integrated and structured approach to CI can lead to missed strategic opportunities and underutilization of available information (Muñoz-Cañavate & Alves-Albero, 2017).

4.1.2. Focus on Describing Current Status Rather Than Predicting Future Trends

Most prior studies in the insurance CI domain primarily focus on describing current conditions or assessing the impact of CI on organizational performance. For instance, studies by Tahmasebi Fard (2018), Mohammadian et al. (2014), and Odiachi et al. (2021) examined the effects of CI on performance and competitive advantage (Mohamadian et al., 2014; Odiachi et al., 2021; Tahmasebifard, 2018).

However, the core nature of CI lies in anticipating future trends and competitor behaviors—an aspect that has been largely overlooked. In today's highly competitive insurance market, the ability to predict competitor actions is far more critical than merely describing the present state.

4.2. Existing Gaps in Machine Learning Studies in the Insurance Industry

4.2.1. Focus on Internal Processes Rather Than Competitor Analysis

A review of past research on machine learning (ML) in the insurance industry reveals that most studies have focused on internal processes such as risk assessment, pricing, claims prediction, and fraud detection. For example, Kajouri Naftchali et al. (2023) concentrated on engineering insurance risk assessment (Kajouri Naftchali et al., 2023), Kaushik et al. (2022) on health premium prediction (Kaushik et al., 2022), and Shi et al. (2024) on claims management (Shi et al., 2024).

Although these applications are valuable, the significant potential of ML in competitor analysis and behavior prediction has been neglected. ML algorithms can, by analyzing competitor-related data (e.g., pricing strategies, product launches, marketing campaigns), identify hidden patterns and forecast future behavior.

4.2.2. Complexity and Need for Interdisciplinary Expertise

As noted by Yang and Shami (2020), implementing ML models requires tuning hyperparameters and a deep understanding of data preprocessing techniques. This implementation complexity, along with the need for specialized knowledge across fields (insurance, data mining, statistics), can limit the broader adoption of ML in CI applications (Yang & Shami, 2020).

4.3. Comparative Analysis of Existing Approaches

A comparison of CI and ML studies in the insurance industry reveals the following:

1. **Geographic Focus**: CI studies have been conducted in various countries (e.g., Iran, South Africa, Brazil, Spain), whereas ML studies have primarily been concentrated in developed countries.
2. **Methodological Differences**: CI research has mostly employed qualitative and questionnaire-based methods (Hamidizadeh et al., 2014), whereas ML studies rely on quantitative and algorithmic methodologies (Kaushik et al., 2022).
3. **Focus Areas**: CI studies tend to focus on strategic and organizational aspects (Muñoz-Cañavate & Alves-Albero, 2017), while ML studies concentrate on operational and technical elements (e.g., claims prediction and fraud detection).

4.4. Identification of Research Gaps

1. **Lack of Systematic Integration**: Despite the high potential of ML to enhance CI, no study has systematically integrated the two domains. This gap is especially significant in the insurance industry, which deals with massive volumes of data.
2. **Limited Focus on Competitor Behavior Prediction**: Although many studies have applied ML for claims and risk prediction, none have used it to forecast competitor behavior.
3. **Absence of a Comprehensive Framework**: A notable gap exists in providing a comprehensive framework that integrates the strategic dimensions of CI with the analytical capabilities of ML.
4. **Neglect of Unstructured Data**: Most ML studies in the insurance sector focus on structured data, while a significant portion of competitive information resides in unstructured data sources (e.g., news, social media).
5. **Lack of Performance Evaluation Criteria**: There is a clear lack of standardized metrics for evaluating the effectiveness of integrated CI-ML models in the insurance industry.

5. Proposed Framework for a Machine Learning-Based Competitive Intelligence Model

5.1. Overall Architecture of the Proposed Model

In light of the identified research gaps, the proposed framework consists of three core layers:

- **Data Collection Layer**: Includes an automated system for structured data collection (e.g., prices, products), a data extraction engine for unstructured content (e.g., news, social media), and API interfaces for accessing market and industry data.
- **Processing and Analysis Layer**: Comprises data preprocessing and cleaning, ML algorithms for pattern analysis, a competitor behavior prediction engine, and an intelligent alert system.
- **Decision-Making Layer**: Includes interactive dashboards for insight visualization, a decision support system for strategic recommendations, and a feedback mechanism for continuous model improvement.

5.2. Proposed Methodology

The proposed framework adopts a hybrid methodology consisting of:

- **Exploratory Phase**: Involves in-depth interviews with insurance industry experts, content analysis of industry documents and reports, and identification of key variables influencing competitor behavior.
- **Model Development Phase**: Covers system architecture design, ML algorithm selection and tuning, and development of the competitor behavior prediction system.
- **Evaluation and Improvement Phase**: Involves testing the model with real data, collecting user feedback, and continuously optimizing the model.

5.3. Core Components of the Model

- **Competitor Behavior Prediction Engine**: Includes analysis of pricing trends, prediction of new products, and estimation of marketing strategies.
- **Intelligent Alert System**: Identifies significant changes in competitor behavior, alerts on potential threats and opportunities, and forecasts the impact of environmental changes.
- **Analytical Dashboard**: Displays trends and patterns, offers interactive reports, and provides strategic recommendations.

This proposed framework can address existing literature gaps and provide a comprehensive solution for integrating competitive intelligence and machine learning in the insurance industry.

6. Discussion and Conclusion

Analyzing competitive behavior in the insurance industry is a fundamental tool for identifying competitors' strategies and market positions. Such behaviors may manifest in various forms, including pricing strategies, types of products and services, distribution channel selection, and customer engagement. Based on different theoretical models such as the Miles and Snow typology and Porter's competitive strategies, insurance companies can anticipate competitors' actions and respond accordingly to maintain or improve their market position. Key indicators for analyzing competitive behavior in the insurance industry include financial, market, and operational metrics. These indicators—such as profitability ratios, market share, and service quality—help businesses assess their rivals and adjust strategies accordingly. In addition, market signals can reflect competitors' future strategies and may include announcements, competitive tactics, and shifts in strategic direction.

External factors influencing competitive behavior include economic conditions, technological advancements, regulatory environments, and market dynamics. Changes in any of these areas can influence competition in the insurance industry, forcing firms to adapt their strategies. For example, technological developments such as the use of Large Language Models (LLMs) can significantly alter claims processing and underwriting practices.

Ultimately, by leveraging these analyses, insurance companies can forecast competitors' behavior, identify innovation opportunities, and strengthen their competitive position. Continuous and up-to-date assessments of competitor behavior enable firms to make informed and efficient strategic decisions, thus enhancing their performance in a highly competitive insurance market.

Studies indicate that competitive intelligence, as a strategic tool, plays a critical role in helping insurance companies navigate the turbulent business environment. Findings suggest that integrating machine learning with competitive intelligence can significantly assist insurance companies in processing vast amounts of structured and unstructured data, forecasting competitor behavior, and identifying market opportunities. Research supports the notion that implementing intelligent systems based on machine learning in areas such as claims prediction and fraud detection can lead to significant cost savings and improved operational efficiency. However, challenges such as data quality, imbalanced datasets, and the need for infrastructure investments remain significant barriers to digital transformation in the insurance sector. Notably, studies have shown that the application of advanced machine learning techniques across various insurance functions—including risk management, customer service, and market analysis—can yield substantial competitive advantages. However, the success of these solutions requires careful consideration of issues such as model interpretability, continuous algorithm updates, and compliance with regulatory requirements.

Overall, the findings emphasize that investment in competitive intelligence and machine learning can support insurance companies in achieving sustainable competitive advantage and increasing market share, provided that technical and organizational implementation challenges are effectively managed.

Moreover, the findings of this review highlight the transformative impact of machine learning on insurance processes. Advanced algorithms that provide data-driven decision-making, real-time insights, and accurate predictive capabilities empower insurers to gain an edge in today's competitive landscape. Techniques such as predictive modeling, time series analysis, and Monte Carlo simulations have significantly enhanced precision in risk management, pricing, and financial planning.

Nonetheless, challenges such as data quality, model complexity, and ethical considerations still require attention. Future trends point toward deeper integration of artificial intelligence, data fusion, and intelligent document processing—all of which promise to further transform the industry. For success, insurance companies must strike a balance between technological advancement and customer needs, while also giving due consideration to regulatory and privacy requirements.

In conclusion, investing in machine learning and competitive intelligence not only boosts operational efficiency but also enables personalized services and improves customer experience. These developments can, in the long term, contribute to the financial stability of the insurance industry and foster the delivery of more innovative services.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

Acknowledgments

Authors thank all who helped us through this study.

Conflict of Interest

The authors report no conflict of interest.

Funding/Financial Support

According to the authors, this article has no financial support.

References

Abdellaoui, S., & Nader, F. (2015). Semantic data warehouse at the heart of competitive intelligence systems: Design approach 2015 6th International Conference on Information Systems and Economic Intelligence (SIIE). https://doi.org/10.1109/ISEI.2015.7358736

Averch, H. A. (1990). *Private Markets and Public Intervention: a Primer for Policy Designers*. Pittsburgh: University of Pittsburgh Press. https://doi.org/10.2307/jj.12124961

Babaimehr, H., & Zingir, M. F. (2016). Competitive intelligence has an impact on social responsibility in melli bank branches staff in ardebil province. *International Journal of Management Research and Reviews*, *6*(5), 714. https://ensani.ir/fa/article/463979/

Bitencourt Jorge, C. F., Marinho do Nascimento, N., Ferreira de Souza, J. S., Santarém, V., Pomim Valentim, M. L., & de Carvalho Pazin Vitoriano, M. C. (2019). Use of access to information law in the process of competitive intelligence in the context of the private health in Brasil: An analysis in SulAmerica Insurance. *Revista Cubana de Información en Ciencias de la Salud (ACIMED)*, *30*(1), 1-25. https://www.medigraphic.com/cgi-bin/new/resumenI.cgi?IDARTICULO=87064

Calof, J. (2017). Canadian competitive intelligence practices - a study of practicing strategic and competitive intelligence professionals Canadian members. *foresight*, *19*, 00-00. https://doi.org/10.1108/FS-07-2017-0024

Chakraborti, S., & Dey, S. (2016). Multi-level K-means text clustering technique for topic identification for competitor intelligence 2016 IEEE Tenth International Conference on Research Challenges in Information Science (RCIS). https://doi.org/10.1109/RCIS.2016.7549332

Charpentier, A., Elie, R., & Remlinger, C. (2023). Reinforcement Learning in Economics and Finance. *Computational Economics*, *62*(1), 425-462. https://doi.org/10.1007/s10614-021-10119-4

Cummings, J., & Hartman, B. (2022). Using Machine Learning to Better Model Long-Term Care Insurance Claims. *North American Actuarial Journal*, *26*(3), 470-483. https://doi.org/10.1080/10920277.2021.2022497

du Toit, A. S. A., & Sewdass, N. (2014). Competitive intelligence in Morocco. *African Journal of Library Archives and Information Science*, *24*(1), 3-13. https://www.researchgate.net/publication/262035924_Competitive_intelligence_in_Morocco

Erickson, S., & Rothberg, H. (2012). Balancing knowledge management and competitive intelligence, initial insights. *Journal of Intelligence Studies in Business*, *2*, 15-22. https://doi.org/10.37380/jisib.v2i2.37

Fourati-Jamoussi, F., Niamba, C. N., & Duquennoy, J. (2018). An evaluation of competitive and technological intelligence tools: A cluster analysis of users' perceptions. *Journal of Intelligence Studies in Business*, *8*(1), 5-15. https://doi.org/10.37380/jisib.v8i1.301

Gan, G., & Valdez, E. A. (2024). Compositional Data Regression in Insurance with Exponential Family PCA. *Variance*, *17*(1). https://arxiv.org/abs/2112.14865

García, M., & Esteban, M. (2020). A project management approach to competitive intelligence. *Journal of Intelligence Studies in Business*, *10*, 8-23. https://doi.org/10.37380/jisib.v10i3.636

Gaspareniene, L., Remeikiene, R., & Gaidelys, V. (2013). The opportunities of the use of competitive intelligence in business: literature review. *Journal of Small Business and Entrepreneurship Development*, *1*(2), 9-16. https://jsbed.thebrpi.org/vol-1-no-2-december-2013-abstract-2-jsbed

Hamidizadeh, M. R., Roosta, A., Lajevardi, J., & Mohamadian, M. (2014). Providing a Model for Achieving Sustainable Competitive Advantage Based on Competitive Intelligence in Insurance Industry and Evaluating Affecting Indices and Dimensions. *Asian Journal of Research in Marketing*, *3*(2), 220-233. https://www.semanticscholar.org/paper/Providing-a-model-for-achieving-sustainable-based-Hamidizadeh-Roosta/8c3d6671a960dc7273f8dbb83675ff53bb4bd7fa

Hartman, B., Owen, R., & Gibbs, Z. (2020). Predicting High-Cost Health Insurance Members through Boosted Trees and Oversampling: An Application Using the HCCI Database. *North American Actuarial Journal*, *25*(1), 53-61. https://doi.org/10.1080/10920277.2020.1754242

Jasim, H., Sulaiman, Z., & Zakuan, N. (2020). Influence of competitive intelligence success on business competitive advantage: a conceptual framework. *International Journal of Innovation, Creativity and Change*, *11*(12), 795-807. https://www.ijicc.net/images/vol11iss12/111221_Jasim_2020_E_R.pdf

Johns, P., & Van Doren, D. C. (2010). Competitive intelligence in service marketing: A new approach with practical application. *Marketing Intelligence & Planning*, *28*(5), 551-570. https://doi.org/10.1108/02634501011066492

Kajouri Naftchali, M., Abedi Jafari, A., Rezaei Mirqaed, M., & Kajouri, H. (2023). Analyzing the capability of artificial intelligence and machine learning algorithms in engineering insurance. The 30th National and 11th International Conference on Insurance and Development: The Evolution of the Insurance Industry Ecosystem (Takaful, Governance, and Modern Technologies), https://en.civilica.com/doc/2115331/

Kaushik, K., Bhardwaj, A., Dwivedi, A. D., & Singh, R. (2022). Machine Learning-Based Regression Framework to Predict Health Insurance Premiums. *International journal of environmental research and public health*, *19*(13), 7898. https://doi.org/10.3390/ijerph19137898

Köseoglu, M. A., Morvillo, A., Altin, M., De Martino, M., & Okumus, F. (2020). Competitive intelligence in hospitality and tourism: a perspective article. *Tourism Review*, *75*(1), 239-242. https://doi.org/10.1108/TR-06-2019-0224

Maluleka, M., & Chummun, B. Z. (2023). *A Review of Existing Literature on Competitive Intelligence and Insurance Markets* [[Add page range]].

Maritz, T., & Du Toit, A. (2018). The practice turn within strategy: competitive intelligence as integrating practice. *South African Journal of Economic and Management Sciences*, *21*(1), 1-14. https://doi.org/10.4102/sajems.v21i1.2059

Masello, L., Castignani, G., Sheehan, B., Guillen, M., & Murphy, F. (2023). Using contextual data to predict risky driving events: A novel methodology from explainable artificial intelligence. *Accident Analysis & Prevention*, *184*, 106997. https://doi.org/10.1016/j.aap.2023.106997

McGonagle, J. J., & Vella, C. M. (2012). *Proactive intelligence: The successful executive's guide to intelligence*. Springer Science & Business Media. https://doi.org/10.1007/978-1-4471-2742-0

Mohamadian, M., Saemian, S., Shahrokhy, F., & Mirmoeini, H. (2014). Studying the dynamic model of the competitive intelligence in insurance industry considering time factor. *Advances in Environmental Biology*, *8*(10), 1320-1331. https://go.gale.com/ps/i.do?id=GALE%7CA385404610&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=19950756&p=AONE&sw=w&userGroupName=anon%7E98c314e5&aty=open-web-entry

Muñoz-Cañavate, A., & Alves-Albero, P. (2017). Competitive intelligence in Spain: A study of a sample of firms. *Business Information Review*, *34*(4), 194-204. https://doi.org/10.1177/0266382117735982

Muritala, A. S., & Ajetunmobi, O. A. (2019). Competitive intelligence and sustainable competitive advantage of selected insurance companies in Nigeria. *International Journal of Advanced Research in Statistics Management and Finance*, *7*(1), 214-224. https://internationalpolicybrief.org/wp-content/uploads/2023/10/ARTICLE14-23.pdf

Muritala, A. S., Asikhia, O. U., Makinde, O. G., & Akinlabi, H. B. (2019). Competitive intelligence and employee productivity of selected insurance companies in Nigeria. *International Journal of Innovative Research and Advanced Studies*, *6*(6). https://www.researchgate.net/publication/356105840_Competitive_Intelligence_And_Employee_Productivity_Of_Selected_Insurance_Companies_In_Nigeria

Odiachi, J. M., Kuye, O. L., & Sulaimon, A. H. A. (2021). Driving organisational sustainability in the Nigerian insurance sector: The role of competitive intelligence. *SPOUDAI-Journal of Economics and Business*, *71*(1-2), 37-54. https://ideas.repec.org/a/spd/journl/v71y2021i1-2p37-54.html

Oyomo, A. A. (2019). Customer centricity & competitive intelligence performance in the insurance industry in Western Kenya, East Africa. *European Journal of Business and Management*, *11*(10), 62-75. https://iiste.org/Journals/index.php/EJBM/article/view/47437

Peiris, H., Jeong, H., Kim, J. K., & Lee, H. (2024). Integration of traditional and telematics data for efficient insurance claims prediction. *ASTIN Bulletin: The Journal of the IAA*, *54*(2), 263-279. https://doi.org/10.1017/asb.2024.6

Pirayesh, R., & Alipour, V. (2012). Investigating the relationship between competitive intelligence and the effectiveness of marketing strategies in public and private banks in Zanjan Province. *Business Management Quarterly*, *12*, 1-18. https://jibm.ut.ac.ir/article_29181.html

Rezaei Dolatabad, H., Zeinli, H., & Shokrchizadeh, Z. (2011). Examining the impact of competitive intelligence on creating competitive advantage. *Business Management Perspective*, *38*, 9-24. https://jbmp.sbu.ac.ir/article_94471.html?lang=en

Rezaeian, A., & Lashkarbolouki, M. (2010). Competitive intelligence and strategic decision-making. *Business Management Perspective*. https://jbmp.sbu.ac.ir/article_94288.html?lang=en

Salimi Dangharalu, V. (2015). A comprehensive review of competitive intelligence research in Iranian organizations. Annual Conference on Management and Business Economics, https://en.civilica.com/doc/428623/

Sepahvand, R., Nazarpoori, A. H., & Veisi, M. (2016). The effect of competitive intelligence on organizational performance through orientation (Case study: Insurance Companies Sanandaj). *International Business Management*, *10*(7), 1280-1283. https://makhillpublications.co/files/published-files/mak-ibm/2016/7-1280-1283.pdf

Shi, P., Zhang, W., & Shi, K. (2024). Leveraging Weather Dynamics in Insurance Claims Triage Using Deep Learning. *Journal of the American Statistical Association*, *119*(546), 825-838. https://doi.org/10.1080/01621459.2024.2308314

Tahmasebifard, H. (2018). The role of competitive intelligence and its sub-types on achieving market performance. *Cogent Business & Management*, *5*(1), Article 1540073. https://doi.org/10.1080/23311975.2018.1540073

Turcotte, R., & Boucher, J. P. (2024). GAMLSS for Longitudinal Multivariate Claim Count Models. *North American Actuarial Journal*, *28*(2), 337-360. https://doi.org/10.1080/10920277.2023.2202707

Vahdati, H., Saedi, A., & Shariatnejad, A. (2017). The survey of the effect of strategic intelligence on human capital, structural capital and relational capital in insurance industry. *Organizational Culture Management*, *15*(3), 667-686. https://jomc.ut.ac.ir/article_63638.html?lang=en

Vazifehdoust, H., & Ghasemi, F. (2009). The impact of competitive intelligence on small and medium-sized enterprises (SMEs) in transition. *Journal of Modern Economics and Trade*, *9*, 133-161.

Wanke, P., & Barros, C. P. (2016). Efficiency drivers in Brazilian insurance: A two-stage DEA meta frontier-data mining approach. *Economic Modelling*, *53*, 8-22. https://doi.org/10.1016/j.econmod.2015.11.005

Weiss, A. (2002). A brief guide to competitive intelligence: how to gather and use information on competitors. *Business Information Review*, *19*(2), 39-47. https://doi.org/10.1177/026638202321036222

Yang, L., & Shami, A. (2020). On hyperparameter optimization of machine learning algorithms: Theory and practice. *Neurocomputing*, *415*, 295-316. https://doi.org/10.1016/j.neucom.2020.07.061