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Abstract

Purpose: The aim of the study was to assess the role of machine learning algorithms in enhancing customer relationship management systems in Rwanda.

Materials and Methods: This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

Findings: Algorithms analyze vast amounts of data, allowing businesses to personalize interactions and anticipate customer needs more effectively. For instance, predictive analytics can forecast customer churn, prompting proactive retention strategies. Moreover, sentiment analysis tools gauge customer emotions from feedback, enabling tailored responses and improved service delivery. Machine learning also automates routine tasks like email marketing segmentation, optimizing resource allocation and enhancing overall efficiency. Consequently, CRM systems empowered by machine learning algorithms foster stronger customer relationships, driving business growth through enhanced customer satisfaction and loyalty.

Implications to Theory, Practice and Policy: Technology acceptance model (TAM), resource-based view and diffusion of innovations theory may be used to anchor future studies on assessing the role of machine learning algorithms in enhancing customer relationship management systems in Rwanda. Businesses should adopt advanced ML techniques, such as Long Short-Term Memory (LSTM) models and ensemble learning, to enhance the accuracy of customer segmentation and churn prediction, leading to more personalized marketing strategies and improved customer retention. Policymakers should develop and enforce stringent data privacy and security regulations to protect customer data used in ML-enhanced CRM systems.

Keywords: *Machine, Learning Algorithms, Customer Relationship, Management Systems*

INTRODUCTION

Customer Relationship Management (CRM) systems have proven highly effective in developed economies, enhancing customer engagement and driving business growth. In the USA, CRM adoption has resulted in an average sales increase of 29%, with customer retention rates improving by 27% over the past five years (Smith & Johnson, 2020). In Japan, companies leveraging CRM systems reported a 35% increase in customer satisfaction and a 22% reduction in customer churn rates (Tanaka, 2019). These trends highlight the significant impact of CRM systems on improving customer interactions and optimizing marketing strategies. The effectiveness of CRM is evident in the enhanced ability of businesses to understand and anticipate customer needs, leading to more personalized and efficient service delivery.

In developing economies, CRM systems are increasingly becoming vital for business success, albeit with varying degrees of effectiveness. In India, CRM implementation has led to a 25% increase in sales productivity and a 20% improvement in customer service efficiency over the last five years (Sharma & Kumar, 2021). Similarly, in Brazil, businesses have experienced a 30% boost in customer loyalty and a 15% increase in cross-selling opportunities due to effective CRM usage (Silva, 2020). These statistics demonstrate that CRM systems are instrumental in enhancing business performance in developing economies by enabling better customer insights and more effective relationship management. As companies continue to adopt these systems, the potential for growth and improved customer engagement becomes more pronounced.

Customer Relationship Management (CRM) systems have shown substantial benefits in other developing economies, such as Mexico and South Africa. In Mexico, businesses utilizing CRM systems have reported a 23% increase in sales conversion rates and a 19% enhancement in customer service response times over the past five years (Gonzalez & Martinez, 2020). This improvement highlights the critical role of CRM in streamlining sales processes and fostering more effective customer interactions. In South Africa, the adoption of CRM systems has led to a 26% increase in customer loyalty and a 21% reduction in marketing costs (Nkosi, 2019). These trends demonstrate the effectiveness of CRM systems in enhancing operational efficiency and improving customer retention in developing economies.

Customer Relationship Management (CRM) systems are demonstrating substantial benefits in other developing economies, including Indonesia and Turkey. In Indonesia, CRM systems have led to a 24% increase in customer retention and a 21% improvement in sales productivity over the past five years (Suharto & Wibowo, 2020). These advancements highlight the role of CRM in optimizing sales processes and enhancing customer loyalty. Similarly, in Turkey, businesses have experienced a 28% boost in customer satisfaction and a 19% reduction in marketing expenditures due to effective CRM usage (Yildirim, 2019). These trends underline the significance of CRM systems in fostering better customer relationships and operational efficiencies in developing economies.

The success of CRM systems in Indonesia and Turkey is largely attributed to their capability to integrate customer data and streamline communication channels. In Indonesia, companies have utilized CRM to enhance customer engagement, resulting in a 23% increase in customer satisfaction scores (Suharto & Wibowo, 2020). In Turkey, CRM systems have facilitated improved customer service and targeted marketing efforts, leading to a 26% increase in customer loyalty

(Yildirim, 2019). These statistics exemplify the transformative impact of CRM systems on business operations, driving growth and improving customer relations in developing economies.

The success of CRM systems in Mexico and South Africa can be attributed to their ability to integrate various customer data sources, enabling businesses to gain a comprehensive view of their customers. In Mexico, companies have leveraged CRM systems to enhance their customer engagement strategies, resulting in a 22% increase in customer satisfaction scores (Gonzalez & Martinez, 2020). Similarly, in South Africa, CRM systems have facilitated better customer relationship management practices, leading to a 25% improvement in customer retention rates (Nkosi, 2019). These statistics underscore the growing importance of CRM systems in driving business success and customer satisfaction in developing economies.

In sub-Saharan Africa, the adoption of CRM systems is gradually gaining traction, with significant positive outcomes observed in Kenya and Nigeria. In Kenya, businesses utilizing CRM systems have reported a 28% increase in customer retention and a 24% rise in sales effectiveness over the past five years (Mwangi, 2022). In Nigeria, CRM adoption has resulted in a 32% improvement in customer satisfaction and a 20% reduction in customer acquisition costs (Okafor, 2021). These trends illustrate the growing importance of CRM systems in sub-Saharan economies, where businesses are increasingly recognizing the value of maintaining robust customer relationships. The effectiveness of CRM in these regions is evident in the enhanced ability to streamline operations and foster stronger connections with customers.

In sub-Saharan Africa, the adoption of CRM systems is showing promising outcomes, particularly in Ghana and Uganda. In Ghana, CRM systems have resulted in a 27% increase in sales effectiveness and a 22% improvement in customer service efficiency over the past five years (Agyeman, 2021). This trend emphasizes the importance of CRM in maintaining strong customer relationships and optimizing sales operations. Similarly, in Uganda, businesses using CRM systems have reported a 30% increase in customer satisfaction and a 25% reduction in customer acquisition costs (Kintu, 2020). These trends reflect the growing recognition of CRM systems' value in enhancing business performance and customer engagement in sub-Saharan economies. The effectiveness of CRM systems in Ghana and Uganda can be linked to their ability to provide comprehensive customer insights and streamline business processes. In Ghana, companies have leveraged CRM to improve customer segmentation and targeted marketing, resulting in a 24% increase in customer loyalty (Agyeman, 2021). In Uganda, CRM systems have facilitated better management of customer relationships, leading to a 28% increase in customer retention rates (Kintu, 2020). These statistics illustrate the critical role of CRM systems in driving business success and fostering strong customer relationships in sub-Saharan economies.

Machine Learning (ML) algorithms have revolutionized Customer Relationship Management (CRM) systems by enabling more efficient and accurate analysis of customer data, leading to enhanced decision-making and customer engagement. Four prominent ML algorithms used in CRM systems include Decision Trees, Support Vector Machines (SVM), K-Means Clustering, and Neural Networks. Decision Trees are effective in segmenting customers based on their behavior and predicting future actions, enhancing targeted marketing efforts (Liu & Wang, 2019). Support Vector Machines are utilized for customer classification tasks, such as identifying high-value customers and predicting churn, thereby aiding in customer retention strategies (Zhang, 2020). K-Means Clustering helps in grouping customers with similar characteristics, allowing businesses to tailor their services and improve customer satisfaction (Patel & Shah, 2018).

Neural Networks, particularly deep learning models, are powerful in analyzing large volumes of customer data to uncover hidden patterns and predict customer preferences, leading to more personalized marketing campaigns (Kim & Ahn, 2019). The effectiveness of these algorithms in CRM systems is evident in their ability to enhance customer segmentation, improve predictive accuracy, and optimize marketing strategies. By leveraging these ML algorithms, businesses can gain deeper insights into customer behavior, leading to improved customer satisfaction and loyalty. Additionally, the integration of ML in CRM systems facilitates automation and real-time decision-making, significantly boosting operational efficiency (Wang & Lin, 2021). Overall, the use of ML algorithms in CRM systems represents a critical advancement in the pursuit of superior customer relationship management and business performance.

Problem Statement

Despite the significant advancements in Customer Relationship Management (CRM) systems, many businesses struggle to effectively analyze and utilize the vast amounts of customer data generated daily. Traditional CRM approaches often fall short in accurately predicting customer behavior, segmenting markets, and personalizing marketing efforts, leading to suboptimal customer engagement and retention rates. Machine Learning (ML) algorithms offer a promising solution by providing sophisticated analytical tools that can uncover hidden patterns and insights from complex datasets. However, the integration and implementation of ML algorithms within CRM systems remain challenging for many organizations due to issues such as data quality, algorithm selection, and computational resources. Addressing these challenges is crucial to fully harness the potential of ML in enhancing CRM systems and driving better business outcomes (Liu & Wang, 2019; Zhang, 2020; Wang & Lin, 2021; Kim & Ahn, 2019).

Theoretical Framework

Technology Acceptance Model (TAM)

Originated by Fred Davis in 1989, the technology acceptance model (TAM) posits that user acceptance of technology is primarily determined by perceived ease of use and perceived usefulness. This theory is highly relevant to the study of machine learning (ML) algorithms in CRM systems, as it helps understand how users (i.e., businesses and employees) perceive and adopt ML technologies. TAM can explain the factors influencing the integration and utilization of ML algorithms in CRM, shedding light on the barriers and drivers of effective adoption (Venkatesh & Davis, 2020).

Resource-Based View (RBV)

Developed by Jay Barney in 1991, the resource-based view (RBV) theory asserts that an organization's resources and capabilities are critical for achieving and sustaining competitive advantage. In the context of ML algorithms in CRM, RBV emphasizes the importance of leveraging advanced analytical capabilities and data as key resources to enhance customer relationships. By applying RBV, the research can explore how organizations can strategically use ML to optimize CRM processes and achieve superior performance (Barney, 2018).

Diffusion of Innovations Theory

Proposed by Everett Rogers in 1962, the diffusion of innovations theory explains how, why, and at what rate new ideas and technology spread through cultures. This theory is pertinent to studying ML algorithms in CRM systems as it addresses the stages of adoption, from initial knowledge to

implementation and confirmation. Understanding the diffusion process can help identify factors that facilitate or hinder the adoption of ML in CRM, thus informing strategies to enhance the uptake and effectiveness of these technologies (Rogers, 2019).

Empirical Review

Liu and Wang (2019) aimed to improve customer segmentation using decision trees and ensemble learning. Their methodology involved applying these algorithms to a large customer dataset from a retail company to analyze purchasing behaviors and demographic information. The study found that decision trees and ensemble learning significantly enhanced segmentation accuracy by identifying distinct customer segments that were previously overlooked. These methods allowed for more precise targeting of marketing efforts, leading to increased customer engagement and sales. Additionally, the study highlighted that ensemble learning, which combines multiple learning algorithms, provided better performance and robustness compared to single algorithm approaches. Liu and Wang (2019) also discovered that using these advanced segmentation techniques resulted in a 20% increase in customer satisfaction. They recommended businesses adopt decision trees and ensemble learning to optimize their CRM systems and improve marketing efficiency. Furthermore, the study emphasized the importance of continuous model training with updated customer data to maintain segmentation accuracy over time. This research underscores the potential of machine learning to transform traditional CRM practices by providing deeper insights into customer behavior and preferences. The study's findings are particularly relevant for large organizations with extensive customer bases where manual segmentation would be impractical and inefficient. Overall, Liu and Wang (2019) demonstrated that integrating machine learning algorithms into CRM systems could lead to significant improvements in customer relationship management and business performance.

Zhang (2020) utilized Support Vector Machines (SVM) to predict customer churn, addressing a critical challenge in CRM systems. The study applied SVM to historical customer data, including transaction history, customer service interactions, and demographic information, to identify patterns that indicated a likelihood of churn. Zhang's methodology involved training the SVM model on a labeled dataset where customer churn outcomes were known, enabling the model to learn distinguishing features of customers likely to leave. The findings showed that using SVM for churn prediction resulted in a substantial improvement in retention rates, with an accuracy rate of over 85%. This high level of predictive accuracy allowed businesses to proactively address issues leading to churn by targeting at-risk customers with retention strategies. Zhang (2020) recommended incorporating SVM into CRM systems for predictive analytics to help companies preemptively mitigate churn and maintain a stable customer base. Moreover, the study suggested that SVM could be combined with other machine learning techniques, such as clustering, to enhance its predictive capabilities further. This research highlights the critical role of machine learning in not only identifying at-risk customers but also in providing actionable insights for retention strategies. Zhang's work provides a valuable framework for businesses looking to leverage advanced analytics to improve customer loyalty and reduce churn. The study's implications extend to various industries, including telecommunications, banking, and subscription-based services, where customer retention is crucial for sustained growth.

Kim and Ahn (2019) focused on using deep learning for customer churn prediction, specifically employing Long Short-Term Memory (LSTM) models. Their study aimed to address the limitations of traditional churn prediction methods by leveraging the sequential nature of customer

interaction data. The methodology involved training LSTM models on a vast dataset of customer behaviors over time, capturing complex patterns and temporal dependencies that static models might miss. The findings demonstrated that LSTM models significantly improved predictive performance, with an accuracy rate of approximately 90%, compared to traditional methods. Kim and Ahn (2019) found that the deep learning approach allowed for more personalized marketing strategies based on the nuanced understanding of customer behaviors. The study recommended businesses integrate LSTM models into their CRM systems to better predict churn and develop tailored retention strategies. Additionally, the research highlighted the importance of data quality and the need for extensive training data to achieve optimal performance with LSTM models. The study also suggested that combining LSTM with other machine learning techniques could enhance the overall predictive capabilities of CRM systems. This research underscores the transformative potential of deep learning in CRM by providing more accurate and actionable insights into customer behavior. By leveraging advanced machine learning techniques, businesses can significantly improve their customer relationship management processes, leading to higher customer satisfaction and retention rates. The study's findings are particularly relevant for industries with complex and dynamic customer interaction patterns, such as e-commerce and financial services.

Patel and Shah (2018) explored K-Means Clustering for customer segmentation, aiming to enhance customer engagement and loyalty. Their methodology involved applying the K-Means algorithm to cluster customers based on purchasing behavior, demographics, and other relevant attributes. The study utilized a large dataset from a retail company, segmenting customers into distinct groups with similar characteristics. The findings revealed that using K-Means Clustering improved customer engagement by enabling more personalized marketing efforts tailored to each segment's preferences and behaviors. Patel and Shah (2018) reported a significant increase in customer loyalty, with a 15% rise in repeat purchases among targeted segments. They recommended integrating clustering techniques into CRM systems to gain better customer insights and improve marketing strategies. Additionally, the study emphasized the importance of regularly updating clusters with new data to reflect changing customer behaviors and preferences. The research highlighted that K-Means Clustering could help businesses identify high-value customers and tailor their marketing efforts accordingly, leading to increased sales and customer satisfaction. Patel and Shah also noted that clustering could aid in identifying underperforming segments, allowing businesses to develop strategies to re-engage these customers. This study underscores the value of machine learning in enhancing CRM by providing more detailed and actionable insights into customer segmentation. The findings are particularly relevant for retail and consumer goods industries, where understanding customer preferences and behaviors is crucial for competitive advantage.

Suharto and Wibowo (2020) examined the impact of CRM systems using machine learning in Indonesian firms, focusing on customer retention and sales productivity. Their methodology involved deploying various machine learning algorithms, including decision trees and clustering, to analyze customer data and enhance CRM functionalities. The study found that ML-enhanced CRM systems significantly boosted customer retention by 20% and increased sales productivity by 25%. Suharto and Wibowo (2020) attributed these improvements to the ability of machine learning to provide more accurate customer insights and automate customer relationship management processes. The study recommended broader adoption of ML in CRM systems across

different industries in Indonesia to achieve similar benefits. Additionally, the research highlighted the importance of continuous model training and updating with new customer data to maintain effectiveness. The study also suggested that businesses invest in employee training to effectively utilize ML-enhanced CRM systems. Suharto and Wibowo's findings underscore the potential of machine learning to transform CRM practices in developing economies, leading to significant improvements in customer engagement and business performance. The research is particularly relevant for industries with high customer interaction volumes, such as retail, telecommunications, and financial services. Overall, the study demonstrated that integrating machine learning into CRM systems could lead to more effective and efficient customer relationship management, driving better business outcomes.

Wang and Lin (2021) investigated real-time decision-making in CRM systems using machine learning, focusing on enhancing customer satisfaction and operational efficiency. Their methodology involved deploying real-time analytics and machine learning models to process live customer data and provide actionable insights. The study found that real-time ML analytics significantly boosted customer satisfaction by enabling timely and informed decision-making. Wang and Lin (2021) reported a 30% increase in customer satisfaction and a 25% improvement in operational efficiency. The study recommended implementing real-time ML analytics in CRM systems to enhance responsiveness and service quality. Additionally, the research highlighted the importance of integrating real-time data processing capabilities with CRM systems to achieve these benefits. The study also suggested that businesses invest in scalable infrastructure to support real-time analytics and ensure seamless integration with existing CRM systems. Wang and Lin's findings underscore the transformative potential of real-time machine learning in CRM by providing immediate and actionable insights into customer interactions. The research is particularly relevant for industries with high volumes of customer interactions, such as retail, hospitality, and financial services. Overall, the study demonstrated that leveraging real-time ML analytics in CRM systems could lead to significant improvements in customer satisfaction and operational efficiency, driving better business outcomes.

Yildirim (2019) assessed the impact of ML on CRM systems in Turkish companies, focusing on neural networks for customer behavior analysis. The study utilized neural networks to analyze customer interactions, preferences, and purchasing behaviors, aiming to uncover complex patterns and improve marketing efficiency. The methodology involved training neural networks on large datasets of customer data to predict future behaviors and preferences. Yildirim (2019) found that neural networks significantly improved marketing efficiency by providing more accurate and detailed insights into customer behavior. The study reported a 20% increase in customer satisfaction and a 15% reduction in marketing costs. Yildirim recommended integrating neural networks into CRM systems to better understand and predict customer behavior. Additionally, the research highlighted the importance of continuous model training with new customer data to maintain predictive accuracy. The study also suggested that businesses invest in data infrastructure to support the computational demands of neural networks. Yildirim's findings underscore the value of machine learning in enhancing CRM by providing deeper insights into customer behavior and enabling more effective marketing strategies. The research is particularly relevant for industries with complex customer interaction patterns, such as e-commerce and financial services. Overall, the study demonstrated that integrating neural networks into CRM systems could lead to significant improvements in customer relationship management and business performance.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

RESULTS

Conceptual Gaps: While Liu and Wang (2019) demonstrated the effectiveness of decision trees and ensemble learning in improving customer segmentation, their study primarily focused on static datasets and traditional retail environments. There is a need for further research on the integration of dynamic, real-time data into these models to enhance predictive accuracy and responsiveness. Additionally, while Zhang (2020) explored the use of SVM for churn prediction, the study did not investigate the potential of hybrid models that combine SVM with other machine learning techniques, such as deep learning or clustering, to further enhance predictive performance. Kim and Ahn (2019) highlighted the advantages of LSTM models for sequential data analysis in churn prediction, yet there is limited exploration of their application in other CRM functions, such as customer lifetime value prediction or personalized marketing. Similarly, Patel and Shah (2018) showed the benefits of K-Means Clustering for customer segmentation but did not address its limitations in handling high-dimensional data or overlapping clusters, suggesting a gap for developing more sophisticated clustering algorithms.

Contextual Gaps: Suharto and Wibowo (2020) provided valuable insights into the impact of ML-enhanced CRM systems in Indonesian firms, but their findings may not be directly applicable to other developing economies with different market dynamics and customer behaviors. Further studies are needed to explore the contextual differences and adapt machine learning models to various cultural and economic environments. Wang and Lin (2021) emphasized the importance of real-time decision-making in CRM, yet there is a gap in understanding the specific infrastructure and resource requirements for implementing these systems in smaller enterprises with limited technological capabilities. Yildirim (2019) focused on neural networks for customer behavior analysis in Turkish companies, highlighting the need for continuous model training. However, there is a lack of research on the specific challenges and best practices for maintaining and updating these models in rapidly changing market conditions.

Geographical Gaps: While the studies by Liu and Wang (2019), Zhang (2020) and Kim and Ahn (2019) provide valuable insights into the application of ML in CRM within Asian markets, there is a significant gap in understanding how these findings translate to other geographical regions, such as Africa or Latin America. The cultural, economic, and technological differences in these regions may affect the effectiveness and implementation of ML algorithms in CRM systems. Suharto and Wibowo (2020) addressed the Indonesian context, but further research is needed to compare the impact of ML-enhanced CRM systems across multiple developing economies to identify common challenges and opportunities. Additionally, the findings of Wang and Lin (2021) and Yildirim (2019) in the context of real-time decision-making and neural network applications in Turkey highlight the need for similar studies in other geographical regions to build a more comprehensive understanding of global CRM practices.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The integration of machine learning (ML) algorithms into Customer Relationship Management (CRM) systems has demonstrated substantial potential in transforming traditional CRM practices and enhancing business performance. Studies have shown that ML techniques such as decision trees, ensemble learning, Support Vector Machines (SVM), Long Short-Term Memory (LSTM) models, and K-Means Clustering significantly improve customer segmentation, retention, and engagement by providing deeper insights into customer behaviors and preferences. The application of these advanced algorithms enables businesses to execute more precise targeting of marketing efforts, predict customer churn accurately, and develop personalized strategies that enhance customer satisfaction and loyalty. However, the successful implementation of ML in CRM systems requires continuous model training with updated data, robust data infrastructure, and addressing specific contextual and geographical challenges. As businesses continue to adopt and refine these technologies, the role of ML in CRM will likely expand, driving further improvements in customer relationship management and competitive advantage across various industries and regions. Future research should focus on exploring the integration of real-time analytics, hybrid models, and the application of ML in diverse economic and cultural contexts to maximize the benefits of these powerful tools in CRM systems.

Recommendations

The following are the recommendations based on theory, practice and policy:

Theory

Future research should explore the integration of hybrid machine learning models that combine techniques such as decision trees, Support Vector Machines (SVM), and deep learning to enhance predictive accuracy and robustness in CRM systems (Kim & Ahn, 2019; Zhang, 2020). This theoretical development could provide a more comprehensive framework for understanding customer behaviors and improving segmentation and retention strategies. Additionally, theoretical models should incorporate dynamic, real-time data processing capabilities to adapt to changing customer behaviors and market conditions. This approach will advance the theoretical understanding of real-time decision-making and its impact on customer satisfaction and business performance (Wang & Lin, 2021). Expanding the theoretical framework by integrating insights from psychology, sociology, and behavioral economics can provide a more holistic understanding of customer behaviors and preferences, enhancing the predictive power and effectiveness of ML algorithms in CRM (Liu & Wang, 2019).

Practice

Businesses should adopt advanced ML techniques, such as Long Short-Term Memory (LSTM) models and ensemble learning, to enhance the accuracy of customer segmentation and churn prediction, leading to more personalized marketing strategies and improved customer retention. Organizations should invest in robust data infrastructure and continuous model training to ensure the effectiveness and scalability of ML-enhanced CRM systems. This includes implementing scalable cloud-based solutions and ensuring high-quality, up-to-date customer data (Suharto & Wibowo, 2020). Providing comprehensive training for employees on the use and interpretation of ML-enhanced CRM tools can maximize their effectiveness. This includes training in data

analytics, machine learning basics, and the strategic application of CRM insights (Patel & Shah, 2018).

Policy

Policymakers should develop and enforce stringent data privacy and security regulations to protect customer data used in ML-enhanced CRM systems. Ensuring compliance with international standards, such as GDPR, will build customer trust and mitigate risks associated with data breaches (Yildirim, 2019). Governments should provide incentives and support for technological innovation in CRM systems, such as grants for research and development in machine learning applications and tax incentives for businesses that adopt advanced CRM technologies (Suharto & Wibowo, 2020). Establishing industry-wide standards and best practices for the implementation and use of ML in CRM can help ensure consistency, effectiveness, and ethical use of these technologies. This includes guidelines for data quality, model transparency, and the responsible use of customer data (Wang & Lin, 2021).

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