MODELING ENTERPRISE RESOURCE PLANNING SYSTEMS FOR BUSINESS INTELLIGENCE AND ANALYTICS

[1]Arinomor Prince & [2]Onyemaobi Bethram Chibuzo

[1,2]Department of Computer Science,
Gregory University Uturu,
Abia State, Nigeria.
E-mail: [1]arinomorp@gmail.com and [2]conyemaobi@yahoo.com

Abstract

Enterprise Resource Planning (ERP) systems have become integral to modern business operations, offering comprehensive solutions for managing and integrating core business processes. This paper explores the modeling of ERP systems for business intelligence and analytics (BIA), emphasizing how BIA streamline operations, enhance data accuracy, and support data-driven decision-making across organizations. The discussion includes an overview of ERP architecture, key development tools, and methodologies employed in modeling ERP systems for BIA. Agile Methodology was adopted in the development, while Lifecycle Management framework was used for managing the ERP system lifecycle, including the modeling, deployment, and ongoing evaluation of the ERP system for Business Intelligence and Analytics. Future trends, such as the integration of AI, the rise of mobile ERP applications, and the transition to cloud-based solutions, were examined to provide insight into the evolving landscape of ERP systems. The paper also reflected on the strategic importance of modeling ERP systems for BIA to maintain competitive edge in today's dynamic business environment. It also highlights essentials of BIA, such as improved process efficiency and collaboration, while addressing the challenges of implementation, cost, and user adoption.

***Keywords**:* ERP Systems, Business Intelligence and Analytics, Agile Methodology, Muti-dimensional Database, Predictive Analysis and Data-driven Decision

INTRODUCTION

Business Intelligence, Data, Business Analytics, and Machine Learning skilled professionals are in great demand and is exploding. According to a report by the U.S. Bureau of Labor Statistics, the demand for Business Intelligence and Analytics (BIA) is set to increase, creating 11.5 million new data-driven jobs by 2026 (Khan, *et. al.*, 2021). Business Intelligence and Analytics bring value to organizations across industries because they are able to solve complex challenges with data and drive important decision-making processes.

In today's rapidly evolving business landscape, organizations face increasing pressure to streamline operations, reduce costs, and maintain agility in response to market demands. Enterprise Resource Planning (ERP) systems have emerged as a cornerstone in achieving these objectives, offering comprehensive solutions that integrate various business processes into a unified platform. From finance and human resources to supply chain management (SCM) and customer relationship management (CRM), ERP systems facilitate seamless communication and data sharing across departments, enabling organizations to operate more efficiently and make data-driven decisions. However, the true potential of ERP systems lies in their ability to be tailored and extended to meet the unique needs of individual businesses (Malesios, *et. al.,* 2020). Application development

within ERP frameworks allows organizations to model and enhance their systems, ensuring that the software aligns perfectly with their specific operational requirements. The modelling can involve everything from developing new modules and features to integrating third-party applications and automating complex workflows. As businesses increasingly recognize the strategic importance of ERP systems, the demand for BIA skilled professionals who can develop and implement these applications is growing. This paper delves into the world of modelling ERP application for BIA, exploring the architecture of the ERP systems, the BIA technological tools and platforms used, and the methodologies that guide successful ERP execution. We will also examine the challenges and risks associated with ERP implementation, such as the complexities of customization, the costs involved, and the need for thorough training and change management to ensure user adoption. Furthermore, the article will explore emerging trends in ERP systems, such as the integration of artificial intelligence and machine learning, the shift towards cloud-based solutions, and the growing importance of mobile ERP applications for business intelligence (BI) and business analytics (BA). These advancements are not only transforming how ERP systems are developed but also how businesses leverage them to gain a competitive edge especially in business intelligence and analytics (Javaid, *et. al.,* 2022).

REVIEW OF RELATED LITERATURE

The study and development of ERP systems have garnered significant attention from researchers and industry experts. This section reviews the key literature on ERP implementation, customization, application development, and emerging trends, providing a foundation for understanding the complexities and opportunities in ERP application development. Park, *et. al.,* (2020) provided a foundational analysis of ERP systems, emphasizing their ability to integrate disparate business processes into a unified system. His work highlighted the complexity of ERP implementations, which often require significant organizational change and process reengineering to align with the system's functionalities.

Onyemaobi and Anyaehie (2022) reviewed critical success factors for ERP implementation, identifying key areas such as top management support, effective project management, and user training. Their research remains influential in guiding organizations through the ERP adoption process. Bender, *et. al.,* (2021), discussed the challenges and trade-offs between ERP customization and standardization. They argued that while customization allows for a better fit with specific business needs, it also introduces complexity and potential risks, such as increased costs and implementation. Hustad and Stensholt (2023), investigated the issues surrounding ERP customization, particularly in large-scale implementations. His work suggested that modular approaches to development could mitigate some of the risks associated with extensive customization.

Park, *et. al.,* (2020), presented several case studies on ERP implementations, focusing on the development of custom applications tailored to specific industry needs. These case studies demonstrated the critical role of customization in achieving a better alignment between ERP systems and organizational processes. Huang, *et. al.,* (2023), provided an in-depth case study of an ERP-based application in the manufacturing sector, illustrating the challenges of integrating ERP with legacy systems and the importance of user involvement in the development process.

Emerging Trends and Technologies in ERP

Chauhan and Jaiswal (2016) examined the growing trend of cloud-based ERP solutions, highlighting their benefits such as scalability, cost efficiency, and enhanced accessibility. Their work reflects the ongoing shift from traditional on-premise ERP systems to more flexible cloud-based models as opined by Mittal, *et. al.,* (2018). Javaid, *et. al.,* (2022), explored the potential of integrating artificial intelligence and machine learning into ERP systems business intelligence analytics. Their research suggested that these technologies could significantly enhance ERP capabilities, particularly in areas like BI predictive analytics and process automation.

Mahmood, *et. al.,* (2020) discussed the adoption of Agile methodologies in ERP application development. They argued that Agile practices, characterized by iterative development and close collaboration between developers and end-users, could address some of the limitations of Waterfall approaches, particularly in dynamic ERP environments. Hastig and Sodhi (2020), proposed a comprehensive framework for managing the ERP system lifecycle, including the development and customization of ERP applications. They emphasized the need for aligning ERP projects with organizational goals and continuously evaluating system performance.

Recent research indicates several key trends shaping the future of ERP systems such as:

i. Cloud-Based Solutions: Aktepe and Dedeoğlu (2024), highlight the growing adoption of cloud-based ERP solutions. Cloud ERP offers benefits such as scalability, lower upfront costs, and enhanced accessibility, which contribute to its increasing popularity over traditional on-premise systems.

ii. **Artificial Intelligence and Machine Learning**: The integration of AI and machine learning into ERP systems is explored by Weerasekara and Gooneratne (2023). These technologies enhance ERP capabilities through predictive analytics and process automation, potentially providing more advanced functionalities and improving data-driven decision-making processes.

The reviewed literature highlights several critical aspects of ERP application development and implementation for BIA which include:

a) **Complexity of ERP Systems:** According to Park, *et. al.,* (2020), ERP systems integrate diverse business processes into a unified platform, which can introduce significant complexity. Bender, *et. al.,* (2021), emphasize that while customization can tailor ERP systems to specific needs, it often leads to increased costs and complexity. This complexity necessitates careful planning to ensure that the system effectively supports business processes.

b) **Critical Success Factors:** Onyemaobi and Anyaehie (2022), identify essential success factors for ERP implementation, including strong management support, effective project management, and comprehensive user training. Similarly, Pozzi, *et. al.,* (2023). stress that these factors are critical for overcoming common ERP challenges such as resistance to change and integration difficulties.

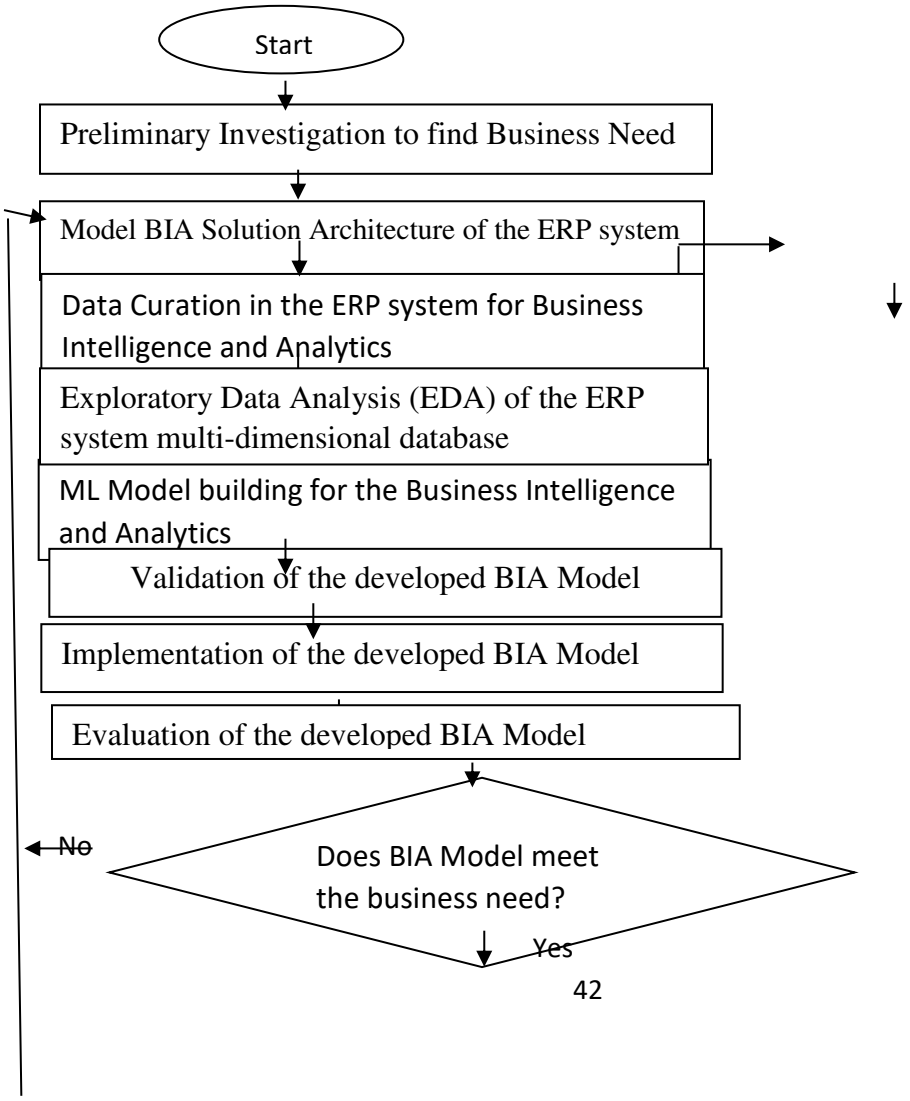
c) **Customization and Integration:** Hustad and Stensholt (2023), discusses the trade-offs between ERP customization and standardization. While customization can enhance system alignment with business needs, it also introduces risks such as integration challenges. Huang, *et. al.,* (2023), further illustrate that integrating ERP systems with existing legacy systems is a significant challenge that requires strategic planning and execution.

Business demand for business analytics and business intelligence has been demonstrated by a number of studies as shown in recent studies (Mariani *et. al.*, 2023). Moreover, successful business intelligence and analytics applications have also been reported in a broad range of industries, from health care and airlines to major IT and telecommunication firms (Jaradat, *et. al.,* 2024). Most successes recorded by organizations that deploy big data analytics are largely noticed in developed countries.

3. Materials and Methods

The methodology employed in Modeling the **ERP Systems for Business Intelligence and Analytics**, significantly impact the project success. Agile Methodology was adopted in the development, noting that iterative development and continuous feedback can address limitations of traditional Waterfall methods. Moreover, Agile approaches allow for flexibility and responsiveness in the development process, which can improve overall project outcomes (Mahmood, *et. al.,* 2020).

The Lifecycle Management framework was used for managing the ERP system lifecycle, including the development, deployment, and ongoing evaluation of the ERP system for Business Intelligence and Analytics. Effective lifecycle management helps ensure that ERP systems remain aligned with organizational goals and adapt to changing business needs (Hustad and Stensholt, 2023). The Machine learning (ML) Agile lifecycle methodology adopted in this research paper is graphically presented in Figure 1 and the processes therein are described in this section.



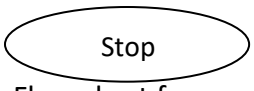


Figure 1: ML Program Flow chart for modeling the ERP system BIA

Obviously, the machine learning approach starts with the investigation of the firm's business need. This business need justifies the required dataset and other resources during the BIA model development. The business need is consistently referenced during various stages of the development, that the model development team (machine learning engineers and the data scientists) does not lose sight of the original aim and objectives. Next important stage is creating the machine learning solution architecture. During this process the team creates a framework (template) of the machine learning BIA model. It is during this stage that the conceptualization of the business need and translation of the business need into technical architecture takes place (Patriarca, *et. al.*, 2022)). At this stage, the development references the digital firm in order to understand their need better and translate it into implementable model.

The data curation stage is a very important phase because from datasets we identify datatype required and the sources from where it will come. Once we know what data is required to build this machine learning BIA model, we can see if such data exists within the ERP system organization or it needs to come from outside of the organization. Data curation also involves acquisition, cleaning, transformation, Indexing, cataloging, Annotation and Maintenance. A sample of the dataset can be used, If the whole dataset is big. Data acquisition happens both from internal and external sources as shown in figure 2. The most important task here is to determine what kind of format the data is available in, such as flat files like csv, XML, or JSON or Oracle database or DB2 database, etc. Classification is made by the development team regarding what is the source of structured data and what is the source of unstructured data. The treatment of unstructured data and structured data in machine learning are very different, hence its identification is equally important. In the next step of data preparation, we perform data wrangling, which largely deals with cleaning up data. Here, all data that do not add any value to our BIA model need are detached and only essential data for the business need are reserved.

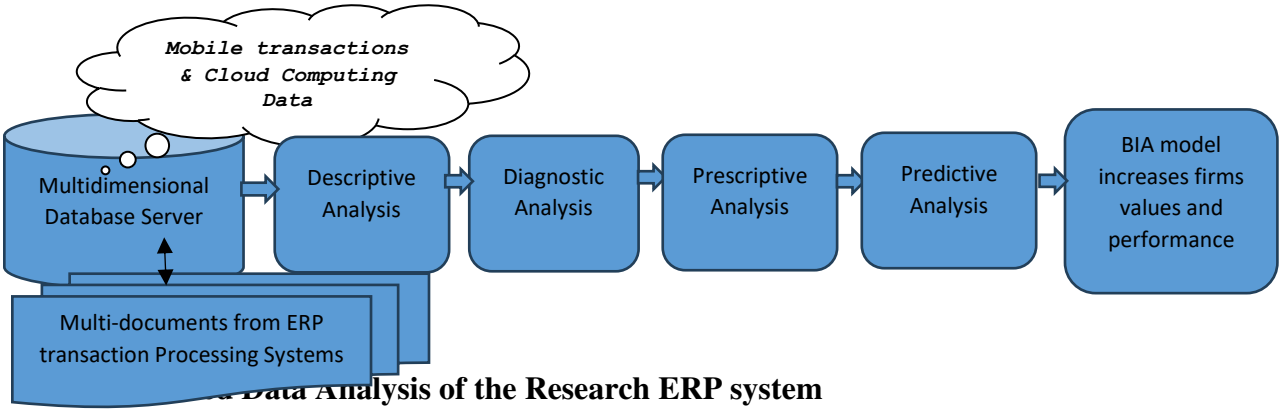
In exploratory data analysis, we look at the basic statistics of data such as its mean, median, and mode and its correlation between the different labels, and we identify whether the data is comprised of numerical or categorical variables, etc. EDA reveals direction to the model building. For instance, the choice of algorithm for the BIA model extremely depends on the kind of variables discovered by the EDA. Model building is strictly tied with EDA. It is the analysis of descriptive statistics, which identifies the modeling technique to use and build a benchmark predictive model. Other procedures and algorithms are used on the dataset to interpret and find the best algorithm for creating the predictive model.

Model validation is done to verify the identified BIA model before we create the model. We use known datasets to see how our model behaves; if it gives good results, then the model is deployed and implemented. Review is done to see if the model meets the business need for which it was developed. If there is a new business need or the model needs to take care of some things that the business requires, then again, we go back to the process of solution architecture data curation, EDA model and building model, and then we do model validation, implementation and review. In

essence, this is a recurring process that goes on until the machine learning model for ERP Business Intelligence and Analytics is terminated.

4. Analysis

Data analytics, business analytics (BA), and business intelligence (BI) are often used interchangeably and they convert data into useful information. However, they differ in purpose and methodologies used for each of the descriptive, predictive, diagnostic and prescriptive analytics as shown in figure 2.



Data Analysis of the Research ERP system

Analytics or data analytics encompasses scrutinizing massive datasets to discover, interpret, and share new insights and knowledge. It can include any one of the four analytics processes in figure 2. Business intelligence (BI) and analytics is a set of tools and processes that help businesses make data-driven decisions by analyzing data. BIA can help businesses identify trends, spot opportunities, and improve performance (Onyemaobi, 2012).

Basic steps in BIA

i. **Collect and store data:** BIA collects data from daily business operations (transaction processing systems) and stores them in multi-dimensional databases (secure locations).

ii. **Analyze data:** BIA uses data analysis tools like Online Analytical Processing (OLAP) to identify trends and patterns in the stored data.

iii. **Share insights:** BIA analysts (skilled professionals) share insights with other teams and clients through reports, graphs, and charts.

iv. **Make decisions:** BIA provides insights that help businesses make informed data-driven decisions to improve and grow the digital firm.

A) Business intelligence (BI): This focuses on querying and reporting and can include reported information from a business analytics (BA) approach. Moreover, business intelligence seeks to answer questions such as what is happening now and where, and also what business

actions are needed based on prior experience. Multimodal dataset from Business organization Business Report Local or Cloud storage Descriptive Analytics Prescriptive Analytics Diagnostic Analytics Predictive Analytics What happened? What is happening, why it is happening and what will happen? What Process for data process? Why do certain events happen? Discovering business opportunities and investments. Predict business opportunities with potential business advantages. Allocate resources to advantages of the predicted opportunities and utilize pattern recognition approaches to predict events.

(B) Business analytics (BA): is a subset of BI that focuses on using data to make predictions and identify strategies for improvement. According to a recent paper (Ajah and Nweke, 2019), business analytics is beyond plain analytics. It sequentially applies a combination of descriptive (what is happening), predictive (why something is happening, what new trends may exist, what will happen next), diagnostic (why did it happen) and prescriptive analytics (what is the best course for the future) to generate new, unique and valuable information that create an improvement in measurable business performance as shown in Figure 2. Analyzed data can be sourced from business reports, database, and ERP transaction data stored in the cloud. Business analytics processes include reporting results about business intelligence and in addition seeks to explain why the results occur based on the analysis.

Outcome of the entire BA analysis: Measure increase in business values and performance Most successes recorded by organizations that deploy big data analytics are largely noticed in developed countries. This is perhaps why huge successes have not been seen for businesses in a developing country. A survey by International Data Corporation (IDC) showed that business analytics was second Information Technology (IT) priorities for large enterprises (Velpula and Pamula, 2022). For some organizations, analytics are used as part of the decision process at varying levels. In addition, organizations are in search of analytics that will primarily help in reducing costs, improving the bottom line, and managing risks. In the past, business analytics and business intelligence were used for structured DBMS-based content to report and understand what happened in the past. With the growth of big data, they can be used alongside big data analytics techniques to provide opportunities for extracting actionable insight from data by using analytical processes and tools. Their implementation is seen in structured Big Data, data analytics, text analytics, web analytics, network analytics, and mobile analytics (Velpula and Pamula, 2022). Moreover, the volume and velocity of big data present an opportunity to use big data and analytical tools to predict the future and make new discoveries (Castelo-Branco *et. al*., 2020).

Analytics involves the use of statistical techniques (measures of central tendency, graphs, and so on), information system software (data mining, sorting routines), and operations research methodologies (linear programming) to explore, visualize, discover and communicate patterns or trends in data (Raghupathi and Raghupathi, 2021). For example, weather measurements collected from metrological agencies can be analyzed and used to predict weather pattern. Furthermore, analysis of business data held the key to the development of successful new products. Analytics process in a big data business world reveals how to tap into the powerful tool of data analytics to create a strategic advantage and identify new business opportunities. It has wide applications which include credit risk assessment, marketing, and fraud detection. The analytic approaches of this research are explored in this section:

4.1 Descriptive analysis: This is a simple statistical technique (graph) that describes what is contained in a data set or database. Descriptive statistics, including measures of central tendency (mean, median, mode), measures of dispersion (standard deviation), charts, graphs, sorting

methods, frequency distributions, probability distributions, and sampling methods. The result of this process can be used to find possible business-related opportunities. For example, the smartphone ownership bar chart can be deployed to show the number of users that own smartphones for an IT firm that wants to determine the market for their mobile payment app based on phone ownership level.

4.2 Diagnostic analysis of the model is the analysis of past data to ascertain the cause of certain events. Therefore, diagnostic analytics augments descriptive analytics by asking why certain events occurred using the patterns in the collected data. The diagnostic analytics process is effectively utilized in machine health monitoring and prognosis, fault detection and maintenance.

4.3 Prescriptive analysis systematizes the power of decision science, management science, and operations research (applied mathematical techniques) for efficient use of allocated resources. Material and other resources of the firm are deployed to take advantage of the projected prospects.

For example, a department store that has a limited advertising budget to target customers can use linear programming models and decision theory to optimally allocate the budget to various advertising media. Linear programming (a constrained optimization methodology) has been used to maximize the profit in the design of supply chains (Waqas, *et. al.*, 2023)**.**

4.4 Predictive analysis is an application of advanced statistical, information software, or operations research methods to identify predictive variables and build predictive models into a descriptive analysis. The results here predict opportunities in which the firm can take advantage to improve their products and services. For instance, multiple regression can be used to show the relationship (or lack of relationship) between ease of use, cost, and security on merchants' acceptance of mobile money payment. Knowing that relationships exist helps explain why one set of independent variables influences dependent variables such as business performance.

These analytic modelling methods may be utilized independently or in combination by the ERP systems to aid the firms' managers in decision making. For instance, a university management can implement business intelligence and analytics from its multidimensional database server to detect scholars who may be at risk of dropping.

RESULTS AND DISCUSSION

Most of the data in multi-dimensional database of the ERP system are unstructured data derived from various data sources and transaction processing systems such as sales records, order, forms text files, weblogs, and social media posts, emails, photo images, audio, and video adverts. The multi-dimensional database is designed to store and manage unstructured data using key-value pairs (Dailey, 2019).

The multi-dimensional database creates strong connections among departments in the firm and enables them to cooperate as a team. It contains data with high-volume, velocity and variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision-making (Neussner and Rapp, 2022).

Business intelligence and analytics has been actively implemented in modeling effective ERP systems for data-driven decision making. For instance, an ERP system for BIA can be technologically advanced to tie bank verification number (BVN) and subscriber identification

module (SIM) registration personal details to a unique digital identity. The BIA will utilize the unique digital identification number (uid) and stream mobile payment transaction data through a mobile device into an ERP system's multidimensional repository. The collated data are monitored on real-time and the standard machine learning techniques applied to discover any fraudulent or incorrect payment alert from a client. Such fraudulent transactions would trigger warning alerts to bank and its mobile operators. The mobile operator's SIM registration record and Global Positioning System (GPS) technology is used to create client's crime chart and alert law enforcement agencies for the offender's arrest. The business intelligence and analytical model running in the bank ERP system also, triggers warning alerts notifying the bank to ignore such transaction requests (Chibuzo and Isiaka, 2020).

Structured and unstructured data of the bank's ERP system through BIA can be mapped to other relevant data, such as network failure log, failed payment transactions, technology awareness data and wrong debit records. These undergoes critical analysis to recognize users experience and discover root causes of low patronage. The evidence is used to improve the business intelligence and analytics model and enable policy that will increase banks and clients' confidence in mobile and other banks transactions. Consequently, help to swiftly realize cashless society, in general.

Despite advancements in ERP systems development, several challenges persist such as:

i. Integration and Legacy Systems: Integrating ERP systems with legacy systems continues to be a significant challenge, as noted by Huang, *et. al.,* (2023), ensuring seamless data exchange and process alignment between new ERP systems and existing systems is crucial for maintaining operational continuity.

ii. User Adoption and Training: Effective user adoption and training are essential for the successful implementation of ERP systems for business intelligence and analytics. This research highlights the need for robust training programs and change management strategies to ensure that users fully leverage new ERP systems for Business intelligence and analytics.

This research findings further highlights the fact that most organizations still rely on traditional technology and depend on spreadsheets for business analytics. There is moderate growth in the use of business Intelligence and analytics within companies. Nonetheless, it is narrowly used within departments or business units, and not integrated across the organization. For some organizations, analytics are used as part of the decision process at varying levels. In addition, organizations are in search of analytics that will primarily help in reducing costs, improving the bottom line, and managing risks. Meanwhile, fear of data accuracy, consistency, and even access is a challenge in the adoption or use of business Intelligence and analytics. Many organizations lack skilled professionals to implement analytics and some businesses that attempted it lack the knowledge to apply the results. Companies that have built an "analytics culture" are reaping the benefits of their analytics investments. Therefore, bridging the knowledge gap for the organization to apply business intelligence and analytics to their ERP systems is vital for effective data-driven decision making and business success in general.

6. CONCLUSION

Modelling of ERP systems for BI analytics is complex yet crucial undertakings for digital organizations seeking to integrate and streamline their business processes. This paper has

highlighted the importance of strategic customization, effective change management, and the adoption of emerging technologies in optimizing ERP systems for B intelligence and analytics. While customization can enhance ERP systems alignment with business intelligent needs, it must be approached carefully to avoid unnecessary complexity and risks. Successful ERP implementation for Business intelligence analytics also relies heavily on robust user training, strong leadership support, and the adoption of agile development methodologies to ensure flexibility and responsiveness to changing requirements.

Recommendations

i. Prioritize Strategic Customization

Customization of ERP systems for BIA can significantly improve their alignment with specific business needs but also introduces complexity. To manage this effectively:

Adopt a Modular Approach: Customize only the modules that are crucial for achieving your business objectives, allowing you to maintain the core ERP system's integrity while tailoring specific functionalities.

Evaluate Trade-Offs: Conduct a thorough cost-benefit analysis before proceeding with the modeling. This will help in understanding the potential impact on system complexity, integration, and future upgrades.

ii. Implement Effective Change Management and Training Programs

User adoption is critical to the success of any ERP system implementation. To ensure smooth adoption and maximize the benefits of business intelligence and analytics:

Invest in Comprehensive Training: Develop training programs that not only teach users how to operate the ERP system but also how to use it effectively to improve their workflows. Make training continuous and tailored to different user roles.

Engage Stakeholders Early: Involve key stakeholders from the beginning to ensure their buy-in and to gather valuable insights that can guide the development process. Engaged stakeholders are more likely to embrace the improved system.

iii. Leverage Emerging Technologies

Incorporating the latest technologies into your ERP system can greatly enhance its capabilities. Consider the following:

Explore AI and Machine Learning: Use artificial intelligence and machine learning to improve data analytics, automate routine tasks, and enhance decision-making. These technologies can provide insights and efficiencies that go beyond traditional ERP capabilities.

Adopt Cloud-Based ERP Solutions: Transition to cloud-based ERP systems for their scalability, cost-effectiveness, and ease of access. Cloud solutions also reduce the need for in-house IT maintenance and simplify system updates.

iv. Adopt Agile Methodologies in ERP System Development

Agile methodologies offer flexibility and responsiveness, which are crucial in ERP systems for BIA. To implement Agile effectively:

Iterative Development: Break down the development process into smaller, manageable iterations that allow for continuous feedback and improvements. This approach helps you adapt to changing business needs and reduce project risks.

Cross-Functional Teams: Form cross-functional teams that include IT professionals, business users, and project managers. This collaboration ensures that the ERP system for BIA is developed in alignment with business requirements and user expectations.

v. Plan for Long-Term Lifecycle Management

Effective lifecycle management ensures that your ERP system continues to deliver value over time. To achieve this:

Establish a Continuous Improvement Process: Regularly assess the ERP system's performance and make adjustments as needed to keep it aligned with evolving business goals. This includes updates, performance monitoring, and user feedback.

Plan for Scalability and Upgrades: Design your ERP system with future growth in mind, ensuring it can scale to accommodate more data, users, and transactions. Also, plan for seamless integration of future upgrades and new functionalities.

References

Ajah, I. A., & Nweke, H. F. (2019). Big data and business analytics: Trends, platforms, success factors and applications. *Big data and cognitive computing*, *3*(2), 32.

Aktepe, Ç., & Dedeoğlu, A. Ö. (2024). Collaborative Supply Chain Management in the Sharing Economy: An Empirical Research. *Ege Academic Review*, *24*(4), 687-714.

Bender, B., Bertheau, C., & Gronau, N. (2021). Future ERP Systems: A Research Agenda. *ICEIS (2)*, 776-783.

Castelo-Branco, F., Reis, J. L., Vieira, J. C., & Cayolla, R. (2020). Business intelligence and data mining to support sales in retail. In *Marketing and Smart Technologies: Proceedings of ICMarkTech 2019* (pp. 406-419). Springer Singapore.

Chauhan, S., & Jaiswal, M. (2016). A meta-analysis of critical success factors in ERP implementations: The case of ERP in the Indian context. Information Technology for Development, 22(4), 675-690.

Chibuzo, O. B., & Isiaka, D. O. (2020). Design and Implementation of Secure Browser for Computer-Based Tests. *International Journal of Innovative Science and Research Technology*, *5*(8), 1347-1356.

Dailey, W. (2019). The big data technology wave. *https://www. skillsoft. com/courses/5372828-thebig-data-technology-wave/. Accessed on March*, *18*, 2019.

Huang, Q., Anwar, M., Oliver, G., & Mahbubur, R. (2023). Investigating cloud ERP adoption in Australian higher education institutions: A case study. *Pacific Asia Journal of the Association for Information Systems*, *15*(2), 4.

Hastig, G. M., & Sodhi, M. S. (2020). Blockchain for supply chain traceability: Business requirements and critical success factors. *Production and Operations Management*, *29*(4), 935-954.

Hustad, E., & Stensholt, J. (2023). Customizing ERP-systems: A framework to support the decision-making process. *Procedia Computer Science*, *219*, 789-796.

Javaid, M., Haleem, A., Singh, R. P., Suman, R., & Gonzalez, E. S. (2022). Understanding the adoption of Industry 4.0 technologies in improving environmental sustainability. *Sustainable Operations and Computers*, *3*, 203-217.

Jaradat, Z., Al-Dmour, A., Alshurafat, H., Al-Hazaima, H., & Al Shbail, M. O. (2024). Factors influencing business intelligence adoption: evidence from Jordan. *Journal of Decision Systems*, *33*(2), 242-262.

Khan, T. A., Akhunzada, A., & Naseeb, C. A (2021). Conceptual Model to Support the Transmuters in Acquiring the Desired Knowledge of a Data Scientist.

Mahmood, F., Khan, A. Z., & Bokhari, R. H. (2020). ERP issues and challenges: a research synthesis. *Kybernetes*, *49*(3), 629-659.

Malesios, C., Dey, P. K., & Abdelaziz, F. B. (2020). Supply chain sustainability performance measurement of small and medium sized enterprises using structural equation modeling. *Annals of Operations Research*, *294*(1), 623-653.

Mariani, M. M., Machado, I., Magrelli, V., & Dwivedi, Y. K. (2023). Artificial intelligence in innovation research: A systematic review, conceptual framework, and future research directions. *Technovation*, *122*, 102623.

Mittal, S., Khan, M. A., Romero, D., & Wuest, T. (2018). A critical review of smart manufacturing & Industry 4.0 maturity models: Implications for small and medium-sized enterprises (SMEs). *Journal of manufacturing systems*, *49*, 194-214.

Neussner, W., & Rapp, P. (2022). Voucher 4.0—Digitization Potential in Voucher Sales from the Works Council's Point of View. *Developments in Information & Knowledge Management for Business Applications: Volume 3*, 47-81.

Onyemaobi, B. C., & Anyaehie I. S. (2022) Implementing Enterprise Resource Planning (ERP) Systems in Digital Firms.

Onyemaobi, C. (2012). *Design and Implementation of Aerospace Information System*. LAP LAMBERT Academic Publishing.

Park, Y., Fiss, P. C., & El Sawy, O. A. (2020). Theorizing the multiplicity of digital phenomena: The ecology of configurations, causal recipes, and guidelines for applying QCA. *Management of Information Systems Quarterly*, *44*, 1493-1520.

Patriarca, R., Di Gravio, G., Cioponea, R., & Licu, A. (2022). Democratizing business intelligence and machine learning for air traffic management safety. *Safety science*, *146*, 105530.

Pozzi, R., Rossi, T., & Secchi, R. (2023). Industry 4.0 technologies: critical success factors for implementation and improvements in manufacturing companies. *Production Planning & Control*, *34*(2), 139-158.

Raghupathi, W., & Raghupathi, V. (2021). Contemporary business analytics: An overview. *Data*, *6*(8), 86.

Velpula, P., & Pamula, R. (2022). CEECP: CT-based enhanced e-clinical pathways in terms of processing time to enable big data analytics in healthcare along with cloud computing. *Computers & Industrial Engineering*, *168*, 108037.

Waqas, U., Abd Rahman, A., Ismail, N. W., Kamal Basha, N., & Umair, S. (2023). Influence of supply chain risk management and its mediating role on supply chain performance: perspectives from an agri-fresh produce. *Annals of Operations Research*, *324*(1), 1399-1427.

Weerasekara, U., & Gooneratne, T. (2023). Enterprise resource planning (ERP) system implementation in a manufacturing firm: Rationales, benefits, challenges and management accounting ramifications. *Accounting and Management Information Systems*, *22*(1), 86-110.