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Past, Current and Future Trend in Enterprise Information System

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***Abstract*— The huge advancements in internet and communications technology (ICT) have directly influenced industries globally to implement Enterprise Information Systems (EIS). This paper clarifies EIS from various perspectives, drawing upon trends in the past, present, and future. It discusses the challenges encountered during EIS implementation as well as the opportunities it presents for the future, before reaching conclusions.**

***Keyword*— Enterprise Information Systems (EIS), ICT, Cloud Computing, Enterprise Integration (EI), Interoperability.**

I. INTRODUCTION

Effective management and strategic information utilization are significant in obtaining organizational success, particularly in the context of a rapidly evolving business environment. The emergence of the Enterprise Information System (EIS) has transformed the operational processes and interaction within the business environment, facilitating efficient data management, communication, and decision-making across various aspects. These advancements have become an essential asset for enterprises that strive to sustain competitiveness in the digital world to ensure an ongoing success and extend their impact.

Enterprise System (ES) has become a key instrument for extending and integrating business processes, both within and between organizations, across functional boundaries over the past decade [3]. Enterprise Information Systems (EIS) is considered a subset of ES, inclusive of all information systems that elevate the functionality and operational efficiency of enterprise business processes through integration. They comprise a combination of hardware infrastructure, networking solutions, databases, and integrated software applications. In contemporary business practices, EIS serves as the core infrastructure, offering improved accuracy, enhanced security, and cost savings.

The inception of EIS began with the integration of computers into industry in the early 1960s, automating manual tasks and replacing paper-based systems like bookkeeping [4]. This period was marked by the introduction of mainframe computers and the initial development stages of database management systems. The surge in internet technologies has prompted a shift towards web-based solutions for EIS. These developments provide real-time information access and promote collaboration among dispersed teams. Additionally, the emergence of cloud computing in the 21st century further revolutionized EIS, offering scalable computing resources accessible via the Internet. Analyzing these trends aims to offer valuable insights into the EIS evolution over time and anticipate challenges as well as opportunities in effectively leveraging information technology.

II. PAST TRENDS IN EIS

A. *History of EIS*

The Enterprise Information System (EIS) has come for a long time in the industry alongside with the development of computers with the purpose is by developing a suitable IT platform to help many organizations to achieve better economical revenue by maximizing their internal coordination. One of the earliest EIS systems that was adopted is Material Requirement Planning (MRP/I) systems back in the 1960s developed by a tractor and construction manufacturer, J.I. Case that cooperated with IBM in which the systems solely focus on tracking inventory and production to come up with a finer production plan [1]. A decade later marked the introduction of a new system, Manufacturing Resource Planning (MRP II), an updated solution from MRP I as it comes with a great advantage and feature in which it also managed other departments that involved directly and indirectly for the manufacturer. Notably, the vast development in the manufacturing industry due to adoption of the MRP I and MRP II has opened the eyes of other industries to the importance of the systems [1].

B. *Enterprise Resource Planning I (ERP/I)*

ERP/I is a software package with a unified database and integrating applications from multiple business functions (e.g. accounting, sales, engineering and human resources to improve management quality [3]. ERP/I is a software package designed for many enterprises regardless of their respected industry as it is more accessible and cheaper as major computer technology companies like Oracle and JD Edward developed the general ERP solution, avoiding the need of the enterprise to build the system

from scratch like in the MRP I [1]. In contrast, these systems are only limited to the local network of the enterprise and only confine the internal process, thus leading to the introduction of ERP II.

C. Enterprise Resource Planning II (ERP/II)

In 2000, ERP II was introduced in conjunction with the Internet arrival where enterprises were able to share and extract information and data from external sources. For example, the company can control the data movement inside and outside from various important stakeholders (e.g. supplier, partners, customers, etc.) [11]. This active relationship between the enterprise and stakeholders led to the establishment of new EIS such as Supply Chain Management (SCM), Customer Relationship Management (CRM) and Supplier Relationship Management (SRM). This system also emphasizes faster communication with the acquisition of real time data in suitable format across the enterprise.

D. Industry-oriented ERP (IERP)

IERP is a system developed in 2009 for specific industries which are not covered in general purpose ERP. In order to fully resolve issues such as low adaptability in unique business and complex configuration, the software componentization must consist of emphasis on business components, identification of common functionality and similarities in business domain and also utilization of Domain Specific Software Architecture (DSSA) [3].

E. Enterprise Resource Planning III (ERP/III)

The current development of the ERP is to supervise the physical asset and function of an enterprise. This composition of ERP systems lacks the presence of Knowledge Management (KM) function i.e. a fair corporate knowledge to survive in fast-paced industrial advancement. The concept of integrating the KM into the existing ERP framework in 2008 led to production of ERP III [3]. ERP III is defined as a strategy in integrating various business functions while managing good rapport with stakeholders (e.g. supplier and customer, supply chains, product life cycle) to optimize resources by using the modern software and high-end digital technologies such as blockchain, big data, and virtual reality. For example, big data and Business Intelligence (BI) ensures stable control of the operational environment while blockchain applications secure data transmission [6]. All the implementations of the digital technologies will increase flexibility and maximum coverage for the enterprise to be a knowledge-based learning organization.

F. Entire Resource Planning

Entire Resource Planning, also known as Complete Resource Planning (CRP), involves integrating ERP I, ERP II, and ERP III. It encompasses the resources utilized and generated across various industrial sectors, aiming to streamline economic, social, and natural material flows. CRP is built to address main challenges faced by enterprises which are that 1) globalization in Supply Chain Management is moving towards a deeper level, and 2) the surge of expectation for sustainable economic growth and environmental protection [3]. This can be achieved as CRP concentrates on the addition of social material flow (e.g. employee well-being, customer feedback) and natural material flow (e.g. resource consumption, waste generation, energy usage). The system can help the enterprise to gain a more holistic approach in all types of resource management. Fig. 1 illustrates the EIS evolution focusing on ERP development.

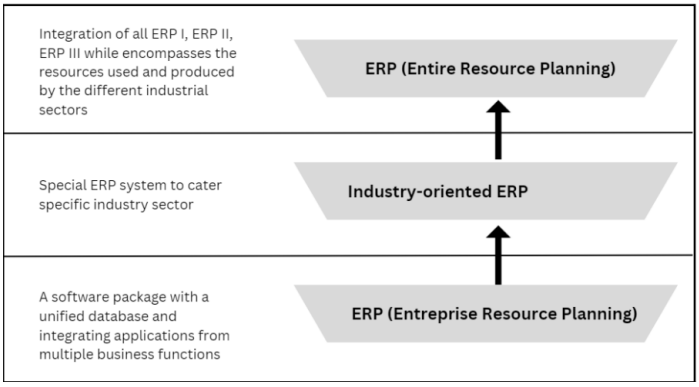

Fig. 1. Diagram of ERP, IERP, ERP tier.

III. CURRENT TRENDS IN EIS

Dynamic changes and innovations within the EIS environment are ongoing in the current digital era as organizations adopt new technologies and strategies to secure a competitive advantage and optimize their operations. These trends are reshaping the way organizations manage, process, and utilize their information resources to achieve strategic goals and provide value to stakeholders. This section delves into several impactful current trends influencing the EIS, ranging from cloud computing to artificial intelligence that transform the business environment. Through a comprehensive analysis, organizations are able to harness EIS to its full extent and foster growth in a business landscape.

A. Generative Artificial Intelligence (AI)

Artificial Intelligence (AI) has emerged as a pivotal trend in EIS, integrating transformative capabilities to automate tasks, enhance customer experiences, and drive business insights. AI enables EIS to analyze extensive data in a swift and accurate manner, recognize patterns, and provide intelligent recommendations. The emphasis on democratized Generative AI signifies increased accessibility, breaking down barriers and enabling a larger audience to harness the potential of this advanced technology [12]. Notably, this particular category of AI, like ChatGPT, exemplifies how AI-generated content adds business value has attracted considerable attention [13]. In light of this, generative AI enhances customer experiences through

personalized interactions and real-time query resolution, thereby improving satisfaction levels. Furthermore, AI also plays a crucial role in cybersecurity within EIS, leveraging algorithms to analyze network traffic patterns, identify anomalies, and preempt potential threats, surpassing conventional security measures. This approach aids organizations to proactively prevent cyber risks, safeguard sensitive data and ensure regulatory compliance. Overall, AI is revolutionizing the application of information technology in EIS within the corporate environment by leveraging human productivity and fostering creativity.

B. Cloud Platforms

Cloud platforms have become a dominant force in EIS, providing access to diverse computing resources including servers, storage, databases, networking, and software, over the Internet. They offer scalability, flexibility, and cost-effectiveness, resulting in cloud platforms to be incredibly fitting for deploying EIS solutions. The practice of developing systems from scratch based on specified requirements is becoming outdated. Pratt [13] stated that companies are currently in the process of determining the most effective approach to modernize applications, IT architecture, and infrastructure, while also migrating legacy systems from on-premises data centers to the cloud.

As opposed to community clouds, industry clouds stand out by providing a comprehensive range of platform capabilities tailored to specific industries, thereby eliminating the necessity for separate maintenance (C.Heard, Nov. 28, 2023) [12]. This allows organizations within the industry to access all necessary tools and resources required from a single cloud provider, promoting a more integrated and efficient approach to IT management. Consequently, this approach also leads to faster solution deployment and facilitates greater collaboration and information exchange among industry stakeholders. Such collaboration encourages the development of industry-specific best practices and standards in rapidly evolving markets.

Industry cloud platforms offer a flexible and interchangeable approach by enabling rapid application and process adjustments. They often work by merging known services such as Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) with cutting edge technologies [12]. “With the advent of widely available APIs and platform-driven solutions, CIOs can now focus on innovations that drive business outcomes rather than getting consumed in topics such as infrastructure, hosting, network, and scalability issues.” quoted Kumar on the impact of industry cloud platforms on EIS in the business world [12].

C. Edge Computing

Edge computing entails a dispersed computing framework that relocates data storage and processing nearer to data sources, typically at the “edge” of the network. This arrangement means that users of cloud applications are more likely to be physically nearer to a server compared to if all servers were centralized in one location. “Transferring this data back and forth to large enterprise cloud platforms for processing is very costly and time consuming,” Englund claimed [10]. Edge computing involves processing data locally on devices such as smartphones, IoT sensors, or edge servers, instead of transmitting over long distances. Processing data closer to its source in edge computing decreases the duration for data to travel from the source to the processing site and back. This reduction in latency is crucial for applications needing real-time or low-latency responses, for example augmented reality, industrial automation, and autonomous vehicles. Moreover, edge computing also aids in relieving the strain on centralized data centers by dispersing processing tasks across a network of edge devices. This architecture enhances scalability in EIS by offloading processing tasks from centralized servers, reducing network congestion and optimizing resource utilization. “It’s important for vendors to explore opportunities with edge ecosystems to disrupt existing business models, even if it puts them in competition with their own legacy business,” Englund added, emphasizing the advantages edge computing provides in the business realm for both organizations and customers.

IV. FUTURE TRENDS IN EIS

In the age of industry revolution 4.0 with the rapid advancement in technology, the framework of ERP will always be in fluid mode with the aims to constantly evolve to provide the better capabilities in maximizing businesses’ profits. We'll discuss some new technologies and disciplines that will shape the future of ERP systems.

A. Internet of Thing (IOT)

The Internet of Things (IoT) is a network infrastructure consisting of numerous interconnected devices that depend on sensory, communication, networking, and information processing technologies [2]. Nowadays, one of the common usages of IOT especially in Malaysia is radio-frequency identification (RFID), a wireless communication to transmit verification data between a microchip and a reader while the other example of IOT is wireless sensor network (WSN) used for sensing and monitoring [5]. The application of IOT can be a game changer in industry as it offers higher quality data in less time that will lead to informed decision making, smart manufacturing and less downtime.

B. Mobile ERP

Mobile ERP is a cloud-based ERP that enables access to ERP systems via mobile devices such as smartphones and tablets, allowing businesses to streamline operations, increase productivity, and improve efficiency [9]. This technology will impact the upcoming working environment, as employees can expect to have the same functionality of the ERP system on their desktops at their fingertips, thus making remote work a new norm

and supporting real-time collaboration among widely dispersed workforces globally.

C. Machine Learning (ML)

Machine learning is a part of Artificial Intelligence that defines how systems undergo data learning to identify patterns and make decisions with minimal human intervention [1]. It is good for automating tasks which is similar to the concept of ERP. Aside from that, ML can extend the feature of predictive analysis, uncovering what will happen to gather much insightful info related to business [2]. ML also will be a good protector for the enterprise digital environment by anticipating any potential issue that may arise. The ML-infused ERP will be useful for the business especially in task automation, relevant insight forecasting and enhanced maintenance workforce.

D. Two tier ERP

Two-tier ERP is a strategy typically employed by large, multinational enterprises, where core processes are handled by the tier one ERP system, or the main ERP system, while company subsidiaries use a tier two ERP system, i.e. less complex and costly to address specific needs [8]. Conventionally, enterprises only implemented a single ERP system to manage whole operations; however, this approach may not be flexible enough to accommodate certain specific reasons for subsidiaries. These reasons include: 1) subsidiaries selling to different markets or having different core targets, 2) subsidiaries located in different countries, 3) subsidiaries needing to invest more money to have the same tier one ERP system, and 4) subsidiaries aiming to use more modern software to advance in a certain way [8]. This approach helps enterprises save money while also giving subsidiaries more control and agility to achieve maximum performance.

V. CHALLENGES

Enterprises often encounter a number of challenges when navigating the landscape of EIS to ensure peak functionality and performance. Strategic planning and innovative solutions are required to resolve these complications, which range from data integration complexity to regulatory compliance demands. There are several challenges in the EIS environment to be addressed.

A. Data value chain management

Efficient data management is essential for insight extraction and well-informed decision making. Organizations must safeguard sensitive data from unauthorized access, making managing the four Vs of big data—volume, velocity, variety, and veracity—an important concern in this aspect. The extensive volume of valuable data that comes from dispersed and heterogeneous channels requires appropriate accessibility in order to be processed and analyzed for utilization in value-added services and processes [7]. Compliance with data protection regulations such as GDPR, CCPA, and HIPAA only adds complexity. Despite the ongoing concerns, there are potential benefits to sharing data with others, particularly stakeholders. Producers have the opportunity to utilize these data sources to obtain comprehensive information into the individual user interactions with a product, informing decision-making across different stages of the product lifecycle for current improvements or future iterations [7]. Developing incentives for secure data sharing remains a notable challenge.

B. Context awareness

Context awareness in EIS acts as a set ability for a current system to interpret external stimuli such as a specified circumstance, environment, and conditions. For instance, context awareness allows an EIS to create tailored recommendations and responses based on the system's current state and external factors such as location and preferences. It is crucial for optimizing EIS functionality and enhancing user experience. Developing accurate models of context is challenging as context can be dynamic and multifaceted. Creating models that capture relevant contextual factors and relationships is vital to cater to users' needs. In modern EIS, the abundance of data often makes it difficult for users to access relevant and crucial information promptly [7]. This information overload hinders decision-making process and overall activity, where users struggle to sift through the vast amount of data to acquire crucial information. Additionally, users need to be able to comprehend the significance of the specifically provided information, requiring an understanding of the current context to grasp its true meaning [7].

C. User adoption and training

The evolution of EIS and concurrent introduction of new technological advancements demands users to adapt and procure additional skills to properly maximize optimal usage of these systems. Continuous education and adequate training ensure users are up to date with the latest development for improved organizational performance and productivity. Addressing this challenge involves several elements, including the need for customized training initiatives, workshops, and educational materials to cater to specific requirements of EIS users. These efforts aim to provide employees with expertise and abilities necessary to navigate intricate EIS interfaces, functionalities, and operations. However, this initiative requires a complex ongoing investment of time, resources, and effort from organizations, especially in large and diverse settings. The challenge lies in establishing and sustaining a culture of continuous learning and skill development with the dynamic nature of EIS. An upgraded system could potentially streamline the transition between diverse knowledge types, promoting the adoption of innovative technology and knowledge transfer schemes to have a vital impact on enhancing ICT-related innovation performance [7].

VI. CONCLUSION

The Enterprise Information System is becoming a comprehensive system applicable across various industrial sectors, leading to increased interest in its implementation. However, it is not advisable for enterprises to invest resources in adopting this system without a thorough understanding of its features, especially regarding its alignment with particular business models. Integrating EIS into the enterprise environment will have significant costs in terms of both finances and time, needing comprehension of the associated challenges. In this paper, the authors have delineated past, present, and future trends in EIS particularly about the ERP, as well as highlighting the challenges associated with its implementation. By understanding the concept of ERP trend and acknowledging the challenge, this paper paves the way for innovation and progress in identifying optimal solutions to address these challenges and enhance the efficiency of EIS in the future. By continuously striving for improvement and embracing emerging technologies, we can empower organizations to achieve greater efficiency, agility, and competitiveness in the ever-changing business environment.

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