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History, Features, Challenges, and Critical Success Factors of Enterprise Resource Planning (ERP) in The Era of Industry 4.0

Md. Al-Amin, Ph.D. Student
University of Massachusetts Lowell, USA
Md. Tanjim Hossain, Ph.D. Student
North Carolina State University, USA
Md. Jahidul Islam, MS
Lamar University, USA
Sanjit Kumar Biwas, BS
University of Chittagong, Bangladesh

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Abstract

ERP has been adopting newer features over the last several decades and shaping global businesses with the advent of newer technologies. This research article uses a state-of-the-art review method with the purpose to review and synthesize the latest information on the possible integration of potential Industry 4.0 technologies into the future development of ERP. Different software that contributed to the development of the existing ERP is found to be Material Requirement Planning (MRP), Manufacturing Resource Planning (MRPII), and Computer Integrated Manufacturing (CIM). Potential disruptive Industry 4.0 technologies that are featured to be integrated into future ERP are artificial intelligence, business intelligence, the internet of things, big data, blockchain technology, and omnichannel strategy. Notable Critical Success Factors of ERP have been reported to be top management support, project team, IT infrastructure, communication, skilled staff, training & education, and monitoring & evaluation. Moreover, cybersecurity has been found to be the most challenging issue to overcome in future versions of ERP.

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This review article could help future ERP researchers and respective stakeholders contribute to integrating newer features in future versions of ERP.

Keywords: Enterprise Resource Planning, ERP, Industry 4.0, future ERP, cloud ERP, critical success factors, ERP security, blockchain

Introduction

Enterprise Resource Planning (ERP) is a vital information management tool for both big and small to medium-sized enterprise (SME) organizations in this age of business competition. ERP is a software package that integrates the entire system of a business and provides a smooth flow of information across the organization (Klaus et al., 2000). It is a configurable software architecture of a central database that integrates the real-time flow of information within and across all the functional areas of the enterprise (Rashid et al., 2002). It has been identified as an effective set of business tools in terms of product development, accounting, inventory, procurement, production, planning, human resource, material management, sales, and marketing. The current age is the age of the fourth industrial revolution, commonly known as Industry 4.0, which needs the integration of personalized and customized connectivity and collaboration of technology and information. The future aim of controlling and connecting the Manufacturing Execution System (MES) with an integrated information framework is thought to be possible through ERP. The advanced research paradigm of the Internet of Things (IoT), Artificial Intelligence (AI), intelligent algorithms, Engineering Data Analysis (EDA), Supply Chain Management (SCM), and Design Chain Management (DCM) are some of the high potential components of Industry 4.0 that can be integrated into the future ERP (Oztemel & Gursev, 2018). Due to the continued success of this software-based tool to expand a unified IT structure within the enterprise, SMEs have been investing more and more to implement it for superior business performance. Moreover, the smart manufacturing paradigm for Industry 4.0 sets the necessity of uninterrupted connectivity of information and machines across enterprises (Al-Amin et al., 2021). However, apart from many advantages, there are some key challenges that SMEs face as significant obstacles, such as higher cost, data security, long implementation process, and resistance to handling ERP-related modifications (Ghobakhloo & Tang, 2018). Nevertheless, ERP still has many tangible and intangible perspectives to offer the contemporary and future business complex by evaluating and identifying more options to compete with the challenges of Industry 4.0. ERP research is a continuous process, which adds newer features and upgrades over time with the evolution of newer technologies as it is observed from its development history. Latest updates on pertaining

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technologies and upcoming trends are always the subject of ERP research. Very few research papers have discussed the perspectives of ERP in the age of Industry 4.0 so far. Therefore, this article purposes on looking for the integrability of the latest technologies, success factors, and security issues in ERP about Industry 4.0.

To depict the overall understanding of the gradual development of ERP including future perspectives, this research article contributes to several sections, such as methods, history, future trends, functional benefits, critical success factors, cybersecurity, and future challenges. History includes different early development of software that contributed to shaping the current state of the ERP, such as MRP, MRPII, CIM, extended ERP, and cloud-based ERP. In cloud-based ERP, the latest editions of ERP architecture have been reviewed. In future trends, the latest emerging technologies that are commonly used in Industry 4.0 systems, have been reviewed. The article aims at helping the reader understand the future shape of the current version of ERP along with the latest disruptive technologies that can be integrated into the ERP in the future to bring a change to the future perspectives of enterprise information and management systems.

Methods

This research article applies the state-of-the-art review method. According to Guevara Patiño (2016), the state-of-the-art review method was introduced at the end of the nineteenth century in the United States, which allows a researcher to approach a bibliographic search of the terms to critically investigate the current development and syntheses of that certain investigative knowledge. It comprises certain basic technical aspects, such as search, description, cataloging, selection, organization, analysis, and interpretation. This research study investigates 105 research articles from various databases such as Scopus, Science Direct, Sage, Emerald Insight, IEEE, Elsevier, and Springer with the help of Google Scholar and the North Carolina State University Library database. The search terms include "ERP history", "ERP AND future trends", "future ERP", "ERP and functions", "future challenges of ERP", "critical success factors of ERP", and "benefits of ERP." Later, those were narrowed down to the most relevant articles. The primary objectives of this research article were to investigate the following research questions:

a) What is the historical background of the current version of ERP regarding software and technology development?
b) What are the future trends of disruptive technologies that could lead to the upgradation of ERP?
c) What are the critical success factors and security threat challenges in implementing future versions of ERP?

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To investigate the aforesaid objectives, a smooth flow of information from historical perspectives on the gradual development of ERP from its earlier stage to the current versions has been synthesized from the literature review in the first section to present a clear view of the functions and evolutions of ERP systems. In the second section, the possibility to integrate potential latest technologies into the current and future versions of ERP has been reviewed to give an idea in advance of how the future ERP would look like. Moreover, different related latest technologies such as blockchain, big data, artificial intelligence, business intelligence, and cybersecurity have been reviewed based on ERP compatibility and future applications in enterprise information management systems. Additionally, in the final section, critical success factors, benefits, and future challenges of ERP have been critically investigated and evaluated. Figure 1 describes the research design used in this research.

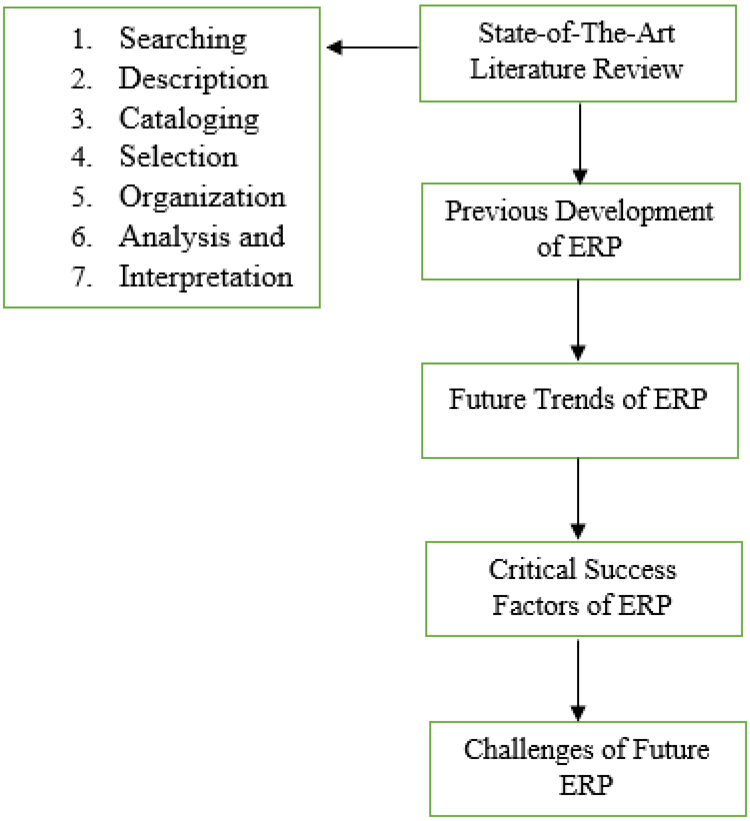

Figure 1. Research design

Total of 46 research articles was investigated about the future trends of technologies that could be integrated into ERP to sustain the pace of the

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Industry 4.0 revolution. The frequently discussed technologies in the previous literature have been listed in table 1.

Table 1. Future trends of technologies in ERP

References	Future Trends of ERP
AlBar and Hoque (2017), Muslmani et al. (2018), Small (2016), Abdulraheem et al. (2020), Gottipati (2020), Jadeja and Modi (2012), Majstorovic et al. (2020), Marinho et al. (2021), Katuu (2020)	Progress of Cloud-based ERP
Omar and Gómez (2016), Omar et al. (2016), Zhu and Lin (2017), Muhammad et al. (2020), Cailean and Sharifi, (2014)	Mobile ERP
Rojek and Jagodziński (2012), Rouhani and Ravasan (2013), Farhat and Owayjan (2017), Owayjan (2017), Goundar et al. (2021), Majstorovic et al. (2020), ElMadany et al. (2022), Katuu (2020)	Artificial Intelligence (AI) incorporated ERP
Zhu and Lin (2017), Rouhani and Mehri (2016), Koupaei et al. (2016), Aldossari and Mokhtar (2020), ElMadany et al. (2022)	Business Intelligence (BI) incorporated ERP
Ande et al. (2020), Khan et al (2020), Majeed and Rupasinghe (2017), Tavana et al. (2020), Sethia and Saxena (2021), Majstorovic et al. (2020)	Internet of Things (IoT)
Parikh (2018), Zheng et al. (2018), Banerjee (2018), Hader et al. (2021), Majstorovic et al. (2020)	Blockchain Technology incorporated ERP
Baig et al. (2019), Liu and Chen (2020), Elragal (2014), Shi and Wang (2018), Jin et al. (2015), Labrinidis and Jagadish (2012), Majstorovic et al. (2020), Bandara and Jayawickrama (2021), Akter and Carillo (2018)	Bigdata
Kim and Chun (2018), Mena et al. (2016), Lee (2018), Majstorovic et al. (2020), Saghiri and Mirzabeiki (2021), Katuu (2020)	Omnichannel Strategy in ERP
Majstorovic et al. (2020), Katuu (2020), Syreyshchikova et al. (2020), Wölfel and Smets (2012)	Automation

History of ERP

ERP is not merely an isolated development of software packages. It has come to the modern stage of business tools through some other initial software developments that happened to use in the industry between 1950 and 1980. The current state of ERP is the chronologically developed and integrated version of material requirement planning (MRP) (1950), MRP II (1970), and computer-integrated manufacturing (CIM) (1980) (Klaus et al., 2000) software (figure 2). Rashid et al. (2002) reported that between the late 1980s and the early 1990s, the ERP came into the market based on the foundation of MRP, MRPII, and CIM with the power of inter-functional integration and coordination of the business processes that include manufacturing, distribution, accounting, financial, project management, inventory, human resource management, service and maintenance, transportation. Today's ERP is the result of the gradual improvement of earlier versions adding newer add-

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ons and extensions, such as advanced planning and scheduling (APS), e-business solutions, customer relationship management (CRM), and supply chain management (SCM).

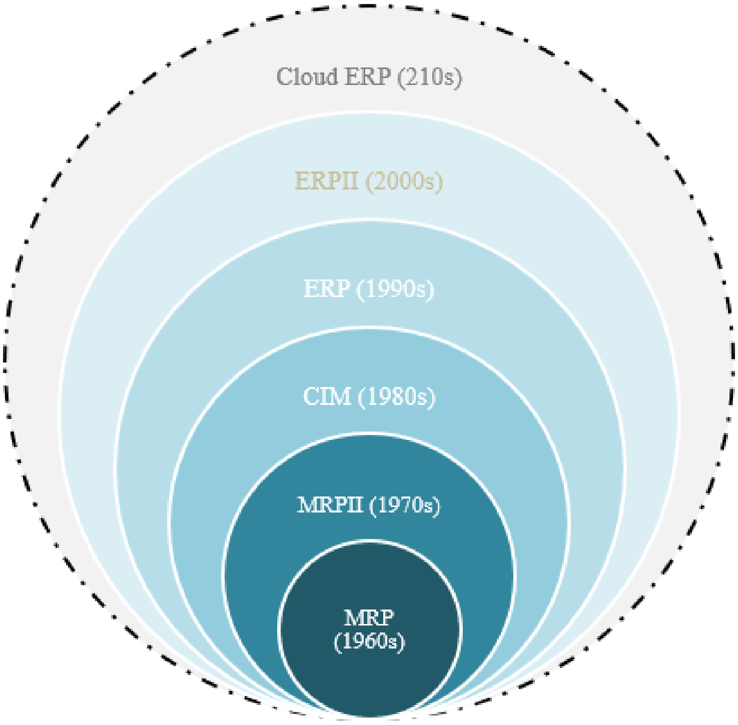

Figure 2. Chronological development of ERP

Material Requirement Planning (MRP)

The emergence of the MRP concept started before the 1950s as soon as the application of computers came into businesses, which introduced bookkeeping and inventory management. Later, in the early 1960s, this use was further developed, adding the bill of material (BOM) and inventory control system (ICM) with it (Patel, 2018). Thus, MRP is considered to be the first predecessor of ERP that evolved after 1950 and got familiar in late 1960 when IBM and JI case jointly introduced this software for planning and scheduling materials for manufacturing products (Jacobs & Weston, 2007). These material management software applications help the enterprise plan for the purchase and production of the components to manufacture items in the master production schedule. It can tell the required amount of materials before the production goes into operation which has greatly controlled inventory levels and improved productivity (Wee & Shum, 1999). Initially, it was designed to support the complex production planning systems in the manufacturing environment. Other than production planning and inventory, it was also able to improve customer service, production scheduling, and

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reduction of manufacturing costs (Noori et al., 2008). MRP supports the production schedule to provide the requirements of raw materials in the right amount and at the right time that helps the production slots adjust and respond to the adverse effects come along with various sudden production ambiguities, such as unanticipated needs, machine breakdowns, latest goods initiation, scarcity of raw materials, and unnecessary rejections (Olaore & Olayanju, 2013). Being an earlier version, MRP had some flaws and functional limitations. It disregards the uncertainties to demand and supply quantities. MRP was not practical for job shops or any continuous processes that were closely connected. It could not function until three major inputs, such as production schedule, product structure, and inventory status, were applied (figure 3) (Dinesh et al., 2014). A big technical support team was needed to take care of the mainframe computer, which was difficult to operate, time-consuming, and costly to implement resulting in the failure to achieve the organizational goals (Katuu, 2020).

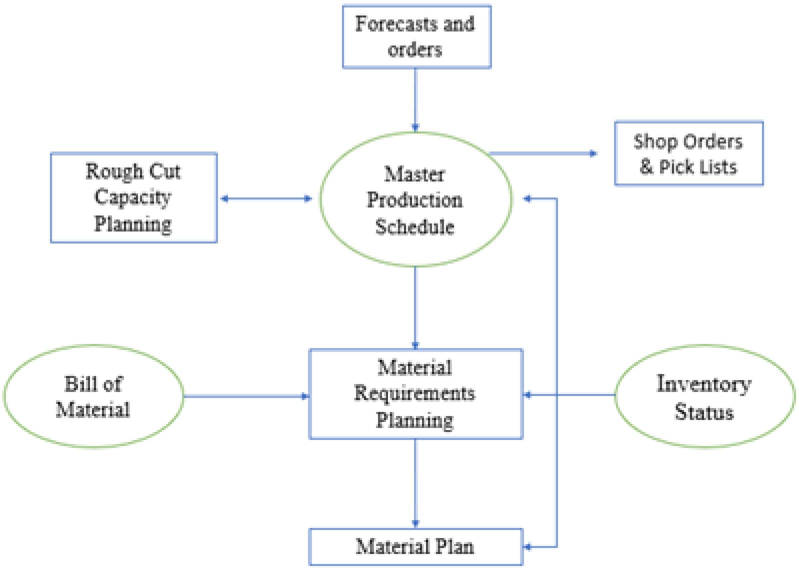

Figure 3. MRP process (adapted from Dinesh et al., 2014)

Manufacturing Resource Planning (MRP II)

In the 1970s, MRP II came into the market and gained gradual upgradation with some additional functions that were absent in the MRP system. MRP II was based on a few assumptions that included the essential planning parameters, such as available capacities, lead times, and processing times that were made more predictable more accurately. Most importantly, MRP II could provide a reasonable master production schedule (Kurbel,

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2012). It was designed with the capability of converting the operations of the production plan into financial terms, which made it conducive to financial planning and control. The most exciting part was its partial simulation capabilities that used to help the management develop the marketing and business plans more efficiently (Olaore & Olayanju, 2013). Material management and capacity management are other added functions that helped manufacturing enterprises control cash flow, arrange materials, manage inventory, and allocate human resources (figure 4). The implementation of MRP II was to reduce inventory, enhance customer service levels, and increase productivity (Li et al., 2001). The enterprise management also sought closed-loop scheduling, floor reporting, and cost reporting capabilities in the transition of MRP to MRP II (Jacobs & Weston, 2007). Mbaya (2000) discussed some notable limitations that MRP II needed to get resolved for a more efficient and wide range of functions. The expensive implementation process and training was the first obstacle to this system. It often could not control functioning with its dynamic system nature. In the case of the shop floor, it possessed complicated and centralized functions that needed synchronizing material flow and order release, which made disturbances to the central computer system for hours (Mbaya, 2000). Having an option for planning, and rescheduling was an organizational demand that MRP II did not offer (Katuu, 2020).

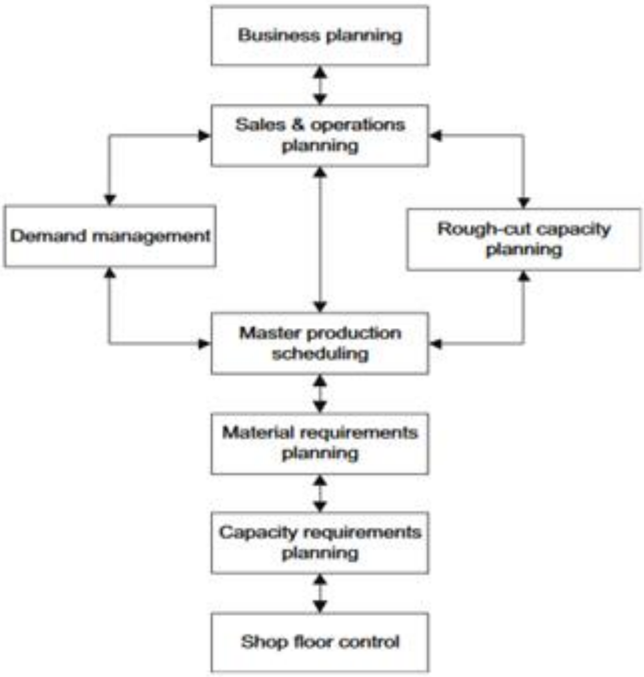

Figure 4. MRPII Process (Kurbel, 2012)

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Computer Integrated Manufacturing (CIM)

Although CIM was different from MRP and MRP II, CIM emerged into the market in the late 1980s intending to offer a computer-integrated manufacturing system, where MRP and MRP II were combined to deliver precise control over manufacturing data. In 1981, Joe Orlicky upgraded the MRP II adding a few more functionalities in Oliver Wight's manufacturing plant, such as demand and time phasing into planning, accounting solutions, and inventory control to calculate material requirements and schedules (Klaus et al., 2000). CIM involved the usage of computer networks across the interconnected production system by integrating advanced technologies in different functional areas effectively to achieve the goal of the enterprise (Nagalingam & Lin, 1999). Being an improved version of the computerized control system, CIM aimed at establishing an interconnection between individual management centers and various control functions. It helped to establish a just-in-time concept in scheduling and material ordering (Beasley et al., 1989). As a progressive development of both production and planning, capacity requirement planning (CRP) was the latest addition to the CIM system, which expedited the CIM toward a manufacturing process optimization approach (Stancu & Drăguţ 2018). As part of the manufacturing process optimization approach, CIM could not provide the expected support on different aspects, such as information system development and enterprise model. Nevertheless, the basis of the CIM system provided a background for the integration of the information system, which eventually shaped the base of the currently available ERP system (Patel, 2018).

Enterprise Resource Planning (ERP)

The development of ERP is based on the abundance and complexity of information and workflow in the industry to support business processes and management (Wortmann, 1998). This complexity of industrial business and management has compelled enterprises to adopt the basis of the earlier developments of MRP, MRP II, and CIM given integrating the entire flow of real-time data into a central database. In the 1990s, this integrated software system emerged as ERP (Rashid et al., 2002). The evolution of the internet and interconnectivity in the 1990s expedited the vendor companies to make and supply various software tools for business management, whereas this adoption process of ERP got accelerated for the same reasons (Wortmann, 1998). In the beginning, ERP used to function in production planning, order planning, distribution, finance, accounting, ledger, human resource, project management, and shop floor control. Gradually the breadth of functions started to extend depending on the increase of functionalities of industrial organizations, which brought the new version of ERP known as extended ERP (Shafi et al., 2019). However, the implementation of ERP was a crucial factor

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that required a substantial amount of time and a skilled workforce for the maintenance that required a huge amount of money to train the staff (Katuu, 2020).

Extended Enterprise Resource Planning (ERP II)

Due to the integration of complex work processes, the industry includes numerous functional departments, textile industry for example has human resource, procurement, sourcing, inventory, warehouse, product development, planning, industrial engineering, production, maintenance, sales, and marketing, logistics, compliance, accounts and finance, and payroll. Moreover, the production department has different parts, such as spinning, knitting, weaving, dyeing, printing, finishing, embroidery, sewing, research and development (R&D), and laboratory. The rush on the delivery and shipping from the brands and retailers within the shortest period has made this process more complicated. Thus, this industry started adopting IT systems with a view to diffusing the smooth flow of real-time information across the enterprise. ERP has made it possible across the business unit to share and view the real-time data required for mutual accomplishments. The latest version of ERP (ERP II) can function in all the aforesaid departments of the industry along with knowledge management, workflow management, customer relationship management, portal capability, and integrated financials (Shafi et al., 2019). The scope of ERP usage surpasses the traditional boundary of functions and applicability nowadays. After encompassing the functionalities in its own enterprise, it is going forward to cooperate with other enterprises. In that case, ERP is being connected with some other software, such as Supply Chain Management (SCM) and Customer Relationship Management (CRM), which evolved in the 2000s under the name of ERP II or extended ERP (Stancu & Drăguţ 2018). In 2000, the initiation of the web browser led to "Web-Based Computing". This computing system showed the way to implement web-based software such as Customer Relationship Management (CRM) into manufacturing software applications. Later, in 2002 ERP II was introduced to provide access to the internet for remote communication between organizations (Cailean & Sharifi, 2014).

Cloud-based ERP

The frequent evolution of new information technologies and their implementation in the management system is encouraging the industry to update the modern versions of ERP with the latest features including extended functionalities (Hernes et al., 2020). The advent of high-speed data transmission including both wired and wireless (5G) internet has paved the way for more opportunities for industrial communication and cyber-physical system. The interconnectivity of the organization has increased tremendously,

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which has compelled the organization to think of extending business collaboration with other organizations through a network-based business system (Wang & Gao, 2020). However, the traditional ERP was so expensive that it was not affordable for most of the SME industry (Cailean & Sharifi, 2014). As part of the continuous development of ERP, the vendors and developers tended to the cloud-based ERP system, which has made it cheaper and affordable (Gottipati, 2020). Cloud-based ERP is based on cloud computing and hosted by the vendor, which evolved in the market in the early 2010s. All the data, memory, processing, maintenance, and security system remain in the cloud server of the host. The components of the whole ERP infrastructure, such as hardware, software, and network connection are provided as a service to the client enterprise (Abdulraheem et al., 2020). The main goal of cloud-based ERP is to make sure the better use of available resources, bring those together to achieve higher output and make space for large-scale data processing within minimum time and cost (Jadeja & Modi, 2012).

Future Trends of ERP and Potential Disruptive Technologies

According to table 1, the top technologies have been reviewed and discussed in detail as follows. How these technologies can contribute to the future shape of ERP to compete with the relatively advanced manufacturing landscape of Industry 4.0 has been the key discussion in this section. All the technologies except "automation" have been included in the further review.

Switching to Cloud ERP

The last couple of decades have experienced tremendous progress in cloud computing. Cloud computing is still a potential and evolving paradigm for the development of ERP as data are no longer stored on-premises with more customized design and flexible access to the server regardless of time and location (Mezghani, 2019). Additionally, cloud ERP offers some distinct benefits over traditional ERP, such as low cost (15% less), fast execution (50%-70%), and agility. A substantial number of organizations have already adopted this technology and numerous are supposed to be adopting it in the current decade. Cloud ERP got 11%-27% increase in global market share in 2016-2017 (AlBar & Hoque, 2017). The IT budget of the organization for the cloud ERP increased 15%-25% in 2016-2017. It is anticipated that more than 70% of organizations will place their IT infrastructure into cloud systems in the current decade (Demi & Haddara, 2018). Muslmani et al. (2018) stated several factors why companies will be tending to cloud-based ERP. Firstly, most of the large companies want to go for Initial Public Offering (IPO) market where cloud ERP is a prerequisite. Secondly, cloud software's reputation and its convenient fit into the market. Thirdly, the cloud-based

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market will be advancing SMEs significantly in the future. Fourthly, adopting new technology is the critical success factor of any company. Fifthly, Cloud-based ERP offers simplified software management and improved performance levels with minimized cost and maintenance hassle. Finally, Cloud is readily available and considered to be the best platform for integrating future IT-based innovation into the future of ERP. Small (2016) reported that data security, cost-effectiveness, reliability, top management support, and competitive pressure have a partial impact on the future adoption of cloud-based ERP for SMEs, whereas manufacturing companies have more intention of adopting cloud-based ERP than service-providing companies.

Mobile ERP

The rapid emergence and development of portable devices and wireless internet has brought the idea of adopting ERP service through smartphone and tablet computers (both iOS and Android) having an active internet connection. Although the idea evolved back in the early 2000s, yet the idea is very new and promising for the future as the use of mobile devices has become an inevitable part of the 21st century (Omar et al., 2016). Figure 5 shows a systematic illustration of mobile ERP. The idea of Mobile ERP in the research article first appeared in 1998, got a detailed outline in 2002, and accelerated in the decade of 2010s. Cloud-based ERP is considered the precursor of mobile ERP as the central database is based on cloud computing (Cailean & Sharifi, 2014). Zhu and Lin (2017) reported several specific advantages of mobile ERP, such as access to data anytime anywhere, real-time information, more customizing option, and quick update. However, as this technological upgradation is still new and in current research, Omar and Gómez (2016) suggested two issues to resolve for future implementation, such as User Interfaces (UIs) and usability because the complex, inflexible and overstuffed design hinders the users operate the device effectively. Recently, Muhammad et al. (2020) developed and proposed an Android-based mobile ERP for a blood management system for hospitals and blood donors in Pakistan to help patients find blood during a medical emergency. The proposed model includes a database of the blood donors, finding nearby blood donors of a specific group, real-time tracking of the donor, text notifications to the donor, and response from the donor.

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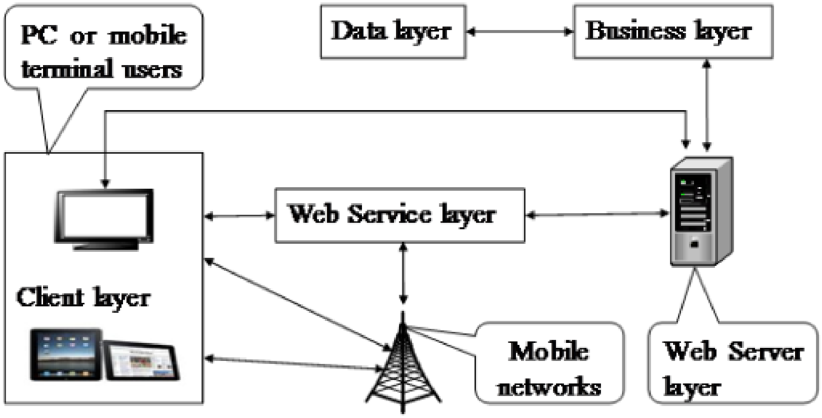

Figure 5. Mobile ERP with business intelligence architecture (Zhu and Lin, 2017)

Artificial Intelligence (AI)

AI is one of the most interesting research topics in the design of modern manufacturing industries based on machine learning. An intelligent system includes the capability to develop new knowledge, self-adaptation, acceptance of faulty or incomplete data, and the ability to create new decisions. This system can monitor coefficients to identify potential threats, forecast, and develop possible action plans. (Rojek & Jagodziński, 2012). Artificial Neural Network (ANN) has been identified as a potential part of AI that can simulate the processing patterns of the human brain using the computation of learning algorithms that can adjust the network behavior. A trained ANN can effectively process the raw data. The future Neural Network (NN) will be multi-layer perceptions including error backpropagation algorithm and radial basis functions that have biological information processing characteristics, such as nonlinearity, learning, ability to process vague and fuzzy information, and ability to simplify those (Rouhani & Ravasan, 2013). It has already been a proven and incorporable tool into ERP for predicting inventory control requirements, cost estimation, loss minimization, and making decisions about marketing segments (Farhat & Owayjan, 2017). Rouhani and Ravasan (2013) proposed an ANN-based ERP structure that can demonstrate the idea of forecasting the ERP attainment level based on the organizational profiles and factors ahead of system implementation and it does not take time frame into account for benefits by interpreting the system profits. The authors recommended that this proposed model will be beneficial for IT managers, CIOs, project managers, and consultants to convince the top management of the benefits of ERP implementation in their organization. Farhat and Owayjan (2017) pointed out several constraints of NN to incorporate it into ERP, such as the inputs of any

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event must be verified by economists and the events should be unique for the organization.

Business Intelligence (BI)

Business intelligence (BI) is a crucial part of business analytics and optimal decision-making in an organizational atmosphere. It is a computerized analytical tool to process data into information and knowledge that helps the organization make business decision (Zhu & Lin, (2017). The integration of BI into ERP may bring some distinct benefits for the organization, such as decisional empowerment, improved interactions with customers, increased flexibility in information generation, increased IT infrastructure capabilities, integrated information across the organization, and improved flow of information across the department (Rouhani & Mehri, 2016). Since most organizations are yet to experience BI in their production planning, hence, BI integrated ERP can provide advanced business data analytics including data mining, text mining, predictive analytics, statistical analysis, and macro analysis. It can be very effective in supporting a vast range of business decisions that range from operational to strategic including both internal and external operational and business data (Koupaei et al., 2016). Aldossari and Mokhtar (2020) suggested several factors important for the adoption of BI into ERP, such as technological factors (system quality, service quality, and information quality), organizational factors (change management, effective communication, and training), and environmental factors (clear vision and planning, competitive pressure and policy, and government role). Nevertheless, it has some limitations to work as it is unable to respond to the rapid changes in the market and cannot prevent unexpected events (Zhu & Lin, 2017).

Internet of Things (IoT) and IIoT

The Internet of Things (IoT) is a network of physical devices embedded with sensors or software that are connected through the internet by a wired or wireless connection to monitor the area around itself, to support and automate a response to the changes in the device ecosystem (Ande et al., 2020). The adoption of promising technological trends and deployments of the Internet of Things (IoT) in the industrial ecosystem is leading to the development of Industrial IoT (IIoT). According to Khan et al (2020) "Industrial IoT (IIoT) is the network of intelligent and highly connected industrial components that are deployed to achieve high production rate with reduced operational costs through real-time monitoring, efficient management and controlling of industrial processes, assets and operational time." The Internet of Things (IoT) and huge data inflows are reviving up the ERP landscape, introducing new prospects for operational superiority and

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workflow automation. For example, Radio Frequency Identification (RFID) tag has potential use in inventory control, such as Walmart has reduced 70% of its inventory using RFID tags. Thus, RFID can be vital incorporation with future ERP for tracking real-time goods in the industry (Majeed & Rupasinghe, 2017). Tavana et al. (2020) stated that due to the connectivity and capability of IoT protocols to collect millions of data from different sources, it can be connected with cloud systems, which can incorporate data with ERP. However, the authors mentioned several challenges of IoT-ERP, such as heterogeneity of devices, functionality, big data, and security concerns.

Blockchain Technology

Blockchain is defined as the backend database that has a distributed, decentralized, immutable, and irreversible ledger. It can approve the exchange without the help of someone at the center (Parikh, 2018). The blockchain is a series of subsequent blocks such as the parent block, uncle block, and genesis block. The chain possesses a comprehensive list of transaction data, such as a conventional public ledger. Each block points to the previous block through a reference that is a hash value of the previous block known as the parent block (Zheng et al., 2018). Banerjee (2018) suggested that in manufacturing enterprises different innovative technologies, such as 3D printing, CAD/CAM, and quality monitoring systems can be integrated into ERP with blockchain technology. Moreover, blockchain can be a medium of engineering ERP design and procurement extension. For example, French automaker Renault applied Blockchain-based Microsoft Azure ERP to control car ownership and maintenance details, track its products, and simplify the new designs. The author also pointed out that blockchain could preserve product information during the entire procurement lifecycle that provides customers access to track-and-trace capabilities, greater visibility, better control, lower risk, and improved regulatory compliance. Integration of blockchain in ERP can help enterprises get the current information from the systems and manage the shareability of such information (Parikh, 2018). Apart from many advantages, it has a few challenges in future implementation. Zheng et al. (2018) stated that scalability is a big concern. Now in the Bitcoin network, the transaction is limited to 7/second which would lead to a large blockchain. Furthermore, privacy leakage, hiding mined blocks, and excessive energy consumption are needed to address and fix in future implementation.

Big Data

Big data means a huge amount of data generated from technological perspectives. The advent and development of high-speed internet, social media, computing systems, and Information Technology (IT) have led to the generation of a myriad amount of data every day (more than 2.5 quintillion

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bytes) that are commonly referred to as big data (Baig et al., 2019). Big Data technology is a complex system including data collection, processing, distributed storage, parallel computing, and visualization that are widely used in enterprise management activities (Liu & Chen, 2020). The incorporation of big data into ERP must enable organizations to have a better “best practice” that will bring a faster and higher quality implementation (Elragal, 2014). Liu and Chen (2020) developed a big data simulation for ERP that could help virtual teaching practice for university ERP teaching. It will also help collect and analyze students’ data that will expedite reasonable adjustments in teaching plans. In 2014, one of the renowned ERP vendors, SAP started collaborating with Databaricks for developing a data-analytical ERP. In 2017, they brought the first big data-based ERP called “Vora” in which ERP could produce business transactional data and big data systems could generate data from different social media platforms, the Internet of Things (IoT), and cellphones. All those data were unified into an analytic system that represented a critical breakthrough in the new generation big data-ERP system (Shi & Wang, 2018). This Vora system showed new opportunities for research on integrating data-driven systems into future ERP. However, the major challenges of big data-ERP remain in data complexity due to complexity in data type, structure, inter-relationships, and computational complexity. Big data comes from multi-sources in huge volumes, which need more efficient computational systems to fit those into the future ERP (Jin et al., 2015). Additionally, heterogeneity, incompleteness, scale, and privacy are several added challenges the future big data-ERP will have to overcome (Labrinidis & Jagadish, 2012).

Omnichannel Strategy

Technological innovations have driven the abundance of possible channels through which enterprises communicate with consumers to improve their business. These adjustments have substantially influenced business models and consumer engagements. Omnichannel refers to the integration of multichannel and cross-channel concepts for a seamless customer experience where multichannel is more than one channel and cross-channel is referred to as the partial integration of several channels (Mirsch et al., 2016). The omnichannel covers most of the functions included in the retailer’s business activities, such as shipping, logistics, sales tools, promotional activities, and performance measurements. Therefore, customers can access services, place orders online and collect the product at the physical store like “click and collect” (Kim & Chun, 2018). Therefore, all the enterprises must make the product available in different channels irrespective of how, where, and when it is ordered (Banerjee, 2018). For a business model with the integration of different channels to give the customer access to information, ERP is the

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convenient option as a significant positive correlation exists between the capability of showing channel information and the integration level of online-offline inventory in a single warehouse (Mena et al., 2016). Lee (2018) reported that the Radio Frequency Identification (RFID) tag has been applied for a smooth flow of information across different supply chain channels of fashion retailing, such as warehouse and inventory for a “see-now-buy-now” business approach. In this case, ERP works as the media to connect the customers with the information channels.

Critical Success Factors (CSFs) in ERP implementation

CSFs are those requirements that must be addressed to implement processes necessary for an organization to compete successfully (Ali & Miller, 2017). CSFs for ERP implementation vary from enterprise to enterprise as these are diversified according to the nature of business and management strategy (Delgir & Pourjabbar, 2018). Loon et al. (2017) identified five critical success factors that are important while implementing ERP in the enterprise, such as benchmark implementation progress on clear milestones and performance metrics, project champion, the competence of the project team, user acceptance, and ERP system capability.

Delgir and Pourjabbar (2018) carried out research on finding the CSFs of implementing ERP in an Iranian bank. They identified the four most important CSFs which are precise selection of ERP package, training, management support, and monitoring and evaluation. Ahmed et al. (2017) studied the CSFs of implementing ERP in small to medium enterprises in Pakistan. Some of the most critical success factors identified by them are management and organizational support, skilled staff, robust user engagement, common goals for all employees, training, good IT infrastructure, and user satisfaction.Chausi et al. (2016) reviewed 22 literatures on CSF and identified 10 CSFs that are found critical for implementing ERP in any enterprise. Some of the most important from those are clear and concise strategy, top management support, skilled workforces, training, monitoring, and evaluation. Woo (2007) carried out a case study in a Chinese company on the critical success factors of implementing its ERP. The author identified several CSFs, such as top management, project team, project management, process change, education and training, and communication. Based on the previously published literature, the topmost seven CSFs for an ERP implementation are as follows:

Top management support

The big IT project immensely depends on sponsorship from the top management. Without their support, in most of cases, the project does not reach its goal (Chausi et al., 2016). Even weak support from top management

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can result in failure of the implementation at the earlier stage. Over 60% of the workforces engaged with ERP implementation want support from their top management from the very initial stage to the final stage (Leandro et al., 2019). They should play a big role in communicating, diffusing direction, and vision among all the workforces to champion the project implementation (Woo, 2007).

Project team

Usually, a vigorous project team consists of competent staff with robust knowledge and past accomplishments who know the organizational detailed objectives and future issues regarding the project requirements. A project team also can communicate across the workforce to diffuse the information (Loon et al., 2017). The team should consist of people with certain qualities, such as knowledge, morals, reputation, flexibility, and motivation (Chausi et al., 2016).

IT Infrastructure

A good IT infrastructure helps facilitate the most suitable system to accommodate the ERP platform (Loon et al., 2017). For a long ERP implementation program, the IT infrastructure of the enterprise needs to be well affluent and organized as it has a substantial effect on the long-term vision and strategy of the enterprise (Leandro et al., 2019).

Communication

Communication between the ERP team and the rest of the workforce is a crucial factor for the success of implementation. Communication must include scopes, objectives, tasks, and formal promotions of ERP-related people (Chausi et al., 2016). The project's significance and management's outlooks need to correspond at every organizational level which should be managed according to the requirements, comments, reactions, and approval of the management (Reitsma & Hilletofth, 2018). Therefore, it is a powerful and structured tool by which an employee can understand what is happening across the enterprise in terms of the objectives and benefits of ERP implementation (Woo, 2007).

Skilled staff

ERP implementation is beyond technological challenges. Other than technology, the staff need to have a clear understanding of the project mission, vision, and soundness of cross-functional activities (Woo, 2007). The workforce should have adequate IT knowledge and skills to execute all the tasks at the individual level in the project (Gheni et al., 2017).

Training and Education

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Operating an ERP is one of the most difficult tasks for the staff which takes a substantial time in ERP implementation. A lack of proper training can frustrate ERP users and can make a negative attitude toward the new system (Woo, 2007). Training is a tactical factor while implementing ERP which at some point needs to be redesigned for making it an effective fit for everyone (Chausi et al., 2016). Efficient and appropriate utilization of the system can only be ensured by offering necessary training for the employees. Early education reduces the demand for expert workforces and helps in the long run (Reitsma & Hilletofth, 2018).

Monitoring and evaluation

Performance metrics play a critical role in to succeed of any implementation project. ERP system performance can be monitored and evaluated by getting user feedback to make sure whether it is heading to realize the business objectives (Chausi et al., 2016). Performance measures are essential to maintain tracking of all events and to determine the attainments against the objectives and targets, while evaluation is vital as early signs of accomplishment help manage pessimism (Reitsma & Hilletofth, 2018).

Challenges of Future ERP and Cybersecurity

The future ERP will entirely be based on cloud computing. Apart from the many benefits of this future form of enterprise tool, it can also offer some challenges. Security risk to the users is a major challenge for the ERP system. Confidentiality of data is one of the key data security issues, which must be taken into account before implementing cloud ERP (Saa et al., 2017). ERP system is perilous due to the amount of data it contains and adopts the complete confidentiality of these data, which are often susceptible to a security breach (Hadidi, & Hadidi, 2020). IDC group conducted a survey in 2013 among 1,100 organizations to figure out the biggest obstacle to accepting cloud-based ERP solutions and around 50% of the organizations reported security issues as their primary concern (Saa, Moscoso-Zea, et al., 2017). Larger organizations often feel insecure to adopt cloud-based ERP systems as cloud providers have the access to their data. Any misconduct or criminal activities of the employees from cloud providers will impose significant risk on the confidentiality and integrity of data of the organization. For instance, the loss of confidentiality of data can occur by spying on communications and revelation by cloud providers to an unapproved third party for financial benefits (Gupta & Misra, 2016). In some cases, cloud providers host multiple clients' data in the same data center, which increases the risk of corporate espionage or information leakage (Puthal et al., 2015). Therefore, cloud providers must concentrate on their security infrastructure and conduct a proper background check at the time of hiring employees to maintain the

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integrity of client data. Switching cloud providers from the existing provider is a complicated, time-consuming, and costly process for an organization. Therefore, organizations should negotiate properly at the beginning with cloud providers and check the comprehensive security framework of the provider to make sure that stringent security strategies will be taken to protect data integrity (Saa et al., 2017).

Human factors are a major source of security breaches besides technical failure due to the lack of proper training of employees in an organization. For instance, Sony Picture Entertainment faced a major security breach in 2014 which cost them around 35 million dollars to recover their IT system (Rîndaşu, 2018). It happened when the directors of the company received an email from Apple asking for email verification. Afterward, hackers collected the password from their Apple accounts which allowed them to gain access to confidential information of the company including Sony service passwords. This incident demonstrates how important it is to train and promote cyber security among employees in the organization (Rîndaşu, 2018). However, a large number of organizations are still unaware to create consciousness among their employees to handle confidential information properly, which makes the ERP application vulnerable. Thus, internal employees can misuse the data of an organization as managers have access to multiple business areas including their departments (Peng & Nunes, 2009). Management may consider allowing access to the employees based on their position in the company to minimize the risk. Administrators of a conventional ERP-adopted organization can have sensitive data on their laptops. Wrong handling of these devices or data can cause data leakage or data loss for the organization (Gupta & Misra, 2016). To implement the ERP system, companies must monitor their system, conduct audits regularly, and train their employees to ensure proper data security. Companies also need to understand the risk associated with data storage infrastructure, and cloud platforms to prevent security incidents to adapt to ERP systems.

Conclusion

The findings of the first research question show that today's ERP is the result of the gradual development of a few other earlier software, such as MRP, MRPII, CIM, and traditional ERP. However, the second research question identifies the need for the integration of many disruptive technologies such as AI, BI, IoT, blockchain technology, big data, and omnichannel strategy to remain updated for the uninterrupted flow of information not only for the interconnection but also for the intra-connection of the enterprises. ERP offers a significant role to play in sharing public data across organizations of the same business nature. AI has already been a proven and incorporable tool into ERP for predicting inventory control requirements, cost estimation, loss

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minimization, and making decisions about marketing segments. The integration of BI into ERP can provide advanced business data analytics including data mining, text mining, predictive analytics, statistical analysis, and macro analysis. IoT can help the enterprise by providing real-time data for tracking goods, machine maintenance, unexpected hazard, inventory, and minimum human intervention. On the other hand, the future ERP is potential to be linked and upgraded with big data analyses. The incorporation of big data into ERP must enable organizations to have a better "best practice" that will bring a faster and higher quality implementation. Additionally, given that future business will be much more customer and social-media-centric, integration of omnichannel strategy into future ERP will enable the enterprises to relate to customers directly giving access them to real-time inventory and warehouse updates. Furthermore, the incorporation of blockchain with ERP can help enterprises get the current information from the systems and manage the shareability of such information. Finally, the third research question identifies several critical success factors that play important roles while implementing ERP, such as top management's support, communication, IT infrastructure, skilled staff, training and education, and monitoring and evaluation. However, apart from many possibilities and benefits, there are still some challenges in future ERP. As the future ERP would be completely in cloud servers, there is always a threat of breaching security systems. Therefore, a strong cybersecurity system for the ERP architecture has been found to be the subject of future concerns for ERP researchers and respective stakeholders. This review article strongly recommends more research on each of the incorporation of new technology, their security protocol, and data privacy in future ERP to make sure business organizations are never at risk of data breaches for the best use of Industry 4.0 technologies.

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