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Enterprise Resource Planning: Past, Present, and Future

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ABSTRACT

The purpose of this article is to provide a broad overview of the history and development of ERPs and outline recent developments with the advent of digital innovations like cloud computing. The research approach in this article was to review literature from both academic journals and industry reports. The article found that ERPs have changed dramatically from precursor systems like integrated control (IC) packages and material resource planning (MRP) systems. They continue to change with the advent of cloud computing, as well as digital innovations like artificial intelligence. While several articles have addressed the evolution of ERPs, this article's unique contribution is that it covers the most recent developments, including discussions on cloud ERPs and postmodern ERPs.

Introduction

An enterprise resource planning (ERP) system is at the center of an institution (Greengard 1). It tackles the core tasks of managing and integrating business processes in real-time. In 2019, Gartner, a global research and advisory firm, stated that ERP systems were one of the largest categories of enterprise software spending. It was forecasted that it would have a compound annual growth rate of 7.1 percent from 2018 to 2022 (Van Decker et al.). Not all global institutions that have made enterprise investments have implemented a form of ERP (Greengard; Katuu). However, many institutions require integrated enterprise-wide functionality in areas like accounting, sales and order management, customer relationship management (CRM), and supply chain management (SCM).

The ERP phenomenon has been a reality for institutions over several decades. This article defines ERPs and briefly traces a history of the phenomenon from the perspective of experts between the 1940s to the present time. The article concludes with two observations made from reviewing the evolution.

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System	Year	Purpose	Constraints
Inventory management and control	1960s	1. Identifying inventory requirements 2. Setting targets 3. Providing replenishment techniques 4. Monitoring item usages	1. Big and clumsy 2. Large technical staff required to support mainframe computers
MRP, hardware and software developments	1970s	1. Move towards target market strategies 2. Emphasis on production integration and planning 3. Utilize software applications for scheduling production processes 4. **Birth of SAP (Systemanalyse und Programmentwicklung) 1972**	1. System was difficult to operate 2. Time consuming 3. Costly to implement 4. No reflection of production and inventory management goals
MRP II	1980s	1. Manufacturing Resource Planning 2. Focus on manufacturing strategies designed to replace stand-alone systems 3. Sales, inventory and purchasing transactions 4. Update inventory and accounting information. 5. **Birth of Peoplesoft, 1987**	1. Absence of planning and scheduling functions. 2. Running on one platform. 3. Requires accurate information
ERP	1990s	1. Enterprise Resource Planning coined by Gartner Group 2. Criteria for evaluating the extent that software was actually integrated both across and within the various functional silos 3. SAP R3 - use of client-server hardware architecture 4. Running on multiple platforms 5. Offers other functions like marketing, finance, HR	1. Implementation may require major changes in the company and its processes 2. Involves an ongoing, possibly never ending, process for implementation 3. Expertise is limited with ongoing staffing problems

Figure 1. History of ERP from the 1960s to 1990s. Source: (Nijher 6)

Defining ERPs

Discussions on ERP systems or platforms have been ongoing for several decades, increasing in the 1990s. In some instances, ERP discussions have claimed the demise of the system (Haddara and Constantini.; Martinez). This

is because ERPs have been considered old-school software in the face of new, smaller, more focused cloud service applications (Rist and Martinez). For institutions that require integrated business processes to support their activities, ERPs remain essential to their success (Rist and Martinez).

According to Nazemi et al. (1000), ERPs can be defined as both a concept and a system. Conceptually, ERP systems "involve the integration of business processes within an organization, with improved order management and control, accurate information on inventory, improved workflow, and SCM, and better standardization of business and best practices" (Nazemi et al. 1000). In this sense, the ERP concept emphasizes institutional changes that take place when the phenomenon is introduced and maintained.

ERP systems are often viewed as "technological infrastructure designed to provide the required functional capability required to turn the ERP concept into a reality" (Nazemi et al. 1000). In this sense, the ERP system is typically an enterprise-wide software platform based on an integrated database. Several functional modules (i.e., financial reporting, accounting, human resources management, sales, or SCM) can be implemented in stages depending on their operational needs (Callejas and Terzi 1; Rist and Martinez). The remainder of this article will explore the development of ERPs as a system rather than a concept.

Regardless of whether an ERP is considered a concept or system, it is more than just a technological artifact. It is often introduced to integrate within the internal value chain of an enterprise (Møller 484). In this sense, the ERP system is the technological manifestation of the ERP concept, benefits, capabilities, goals, and strategic value (Nazemi et al. 1000).

ERP history and evolution

According to Nazemi et al. (1000), the term "ERP" was coined in 1990 by Gartner to describe a new generation of material requirements planning (MRP) systems. However, ERPs and MRPs were all predicated on the use of computing in enterprise environments. The precursor to ERPs and MRPs dates "back" to the late 1940s and mid-1950s when a UK "company", Lyons Teashop, used the early forms of computers to "formulate" material needs, take orders and plan goods distribution. (Agrawal et al. 3; Ferry).

A tenuous historical connection may exist between Lyons Teashop computers and computer-supported organizations a few decades later. Nonetheless, most commentators state that the apparent predecessors of ERPS were systems of the 1960s. These systems automated the identification of inventory requirements, monitoring the usage of items known as inventory control (IC) packages (Nijher 4).

ICs were legacy systems based on programming languages, including COBOL and FORTRAN, on mainframe computers (Rashid et al. 4). These

systems were limited to conducting batch and transaction processing jobs. Yet they were highly expensive and limited big mainframe computer environments (Nijher 4).

New sets of comprehensive systems, or MRPs, were developed in the 1970s. These focused on product integration and planning according to a master production schedule (Rashid et al. 4). SAP, a global leader of ERP systems, developed its first system in the 1970s (Nijher 4).

The 1980s saw the development of the second generation of what were now known as manufacturing resources planning (MRP II) systems, which focused on optimizing manufacturing processes by synchronizing material and production requirements (Rashid et al. 4). Another global ERP brand, People-Soft, was also developed in this period before it was bought in 2005 by another global leader in ERP, Oracle (Nijher 4).

Even though some ERPs appeared in the late 1980s, the most significant enterprise-wide coordination and integration was the 1990s (Rashid et al. 4). ERPs developed and implemented in the 1990s could run on multiple platforms and integrate different business processes, including manufacturing planning, financials, project management, procurement, transportation, and marketing (Nijher 4). This ERP boom was fueled by the rise of relational databases and client/server architecture (Michel 35). Table 1 provides an outline of the evolution of ERPs from the 1960s to the 1990s, including the purpose and constraints for each phase that served as an innovation for the next phase in the evolution (Nijher 6).

During the 1990s ERP vendors built or extended their functionality in features like CRM, SCM, and warehouse management (Rashid et al. 4). The vendors also offered produced analytics and business intelligence features (Michel 35). This led to a new phase in the evolution (extended ERP) as illustrated in Figure 2.

The 2000s iteration of extended ERPs was an intricately integrated system with a three-tier architecture, front presentation layer, middle application layer, and back database layer as illustrated in Figure 3 (She and Thuraisingham 154).

Table 1. Summary of the ERP evolution.

	(Nijher 6)	(Rashid et al. 4)	(Guay)
1960s	Inventory Management and Control	Inventory Control Packages	
1970s	Material Requirements Planning (MRP)	Material Requirements Planning (MRP)	
1980s	MRP II[a]	Manufacturing Resources Planning (MRP II)	Best-of-Breed
1990s	Enterprise Resource Planning (ERP)	Enterprise Resource Planning (ERP)	Monolithic ERP
2000s		Extended ERP	
2010s			Postmodern ERP
2020			??

[a]No explicit definition of the acronym.
?? No characterization of the period.
Source: (Rashid et al. 4; Nijher 6; Guay)

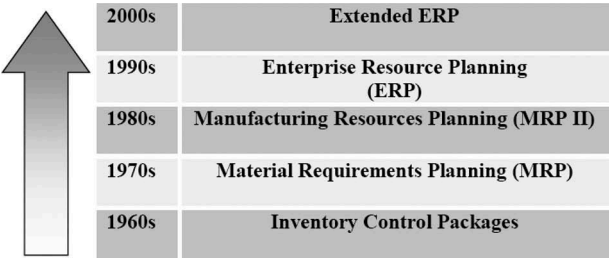| 2000s | Extended ERP |
1990s	Enterprise Resource Planning (ERP)
1980s	Manufacturing Resources Planning (MRP II)
1970s	Material Requirements Planning (MRP)
1960s	Inventory Control Packages

Figure 2. Evolution of ERP from the 1960s to 2000s. Source: (Rashid et al. 4)
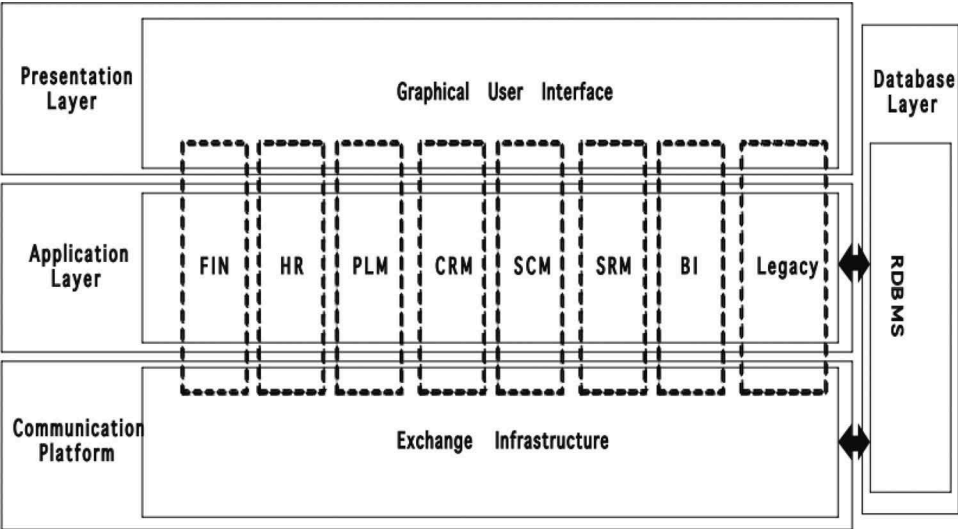

Figure 3. Architecture of an ERP in the 2000s.

In the 2000s the computing world saw the advent of cloud computing. This was defined by the United States National Institute of Standards and Technology (NIST) as a model "for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Mell and Grance 2). NIST initially identified three services models (Mell and Grance 3; Elmonem et al. 2):

(1) Software as a Service (SaaS): Delivers software applications through a thin client interface so that users do not manage or control the underlying infrastructure.
(2) Platform as a Service (PaaS): Delivers middleware used by developers to build and configure SaaS applications.

(3) Infrastructure as a Service (IaaS): Delivers computing power like storage, network, and provision processing use to deploy and run software.

According to Gartner, the ERP market has been undergoing a generational technology shift driven by the advent of cloud computing (Van Decker et al.). Cloud-based ERPs emerged by the mid-2000s due to the perceived benefits of moving away from managing on-premise ERPs, particularly in managing upgrades and maintenance processes (Bjelland and Haddara 1). While most cloud ERPs are provided to the customer as SaaS, a number of PaaS are also common (Elmonem et al. 2; van der Borg 8). Gartner estimates that by 2021 nearly 32% of large enterprises with ERP systems up for replacement would switch from on-premise to SaaS service model (Van Decker et al.).

Figure 4 shows a basic abstraction of the cloud computing environment (Habadi et al. 2).

In the mid-2010s previous iterations of ERPs were loosely coupled solutions. Therefore, Gartner coined a new term of postmodern ERPs that were seen as more agile and outward-facing (Guay "Postmodern Erp Strategies and Considerations for Midmarket It Leaders"). A postmodern ERP is described as a technology strategy that "automates and links administrative
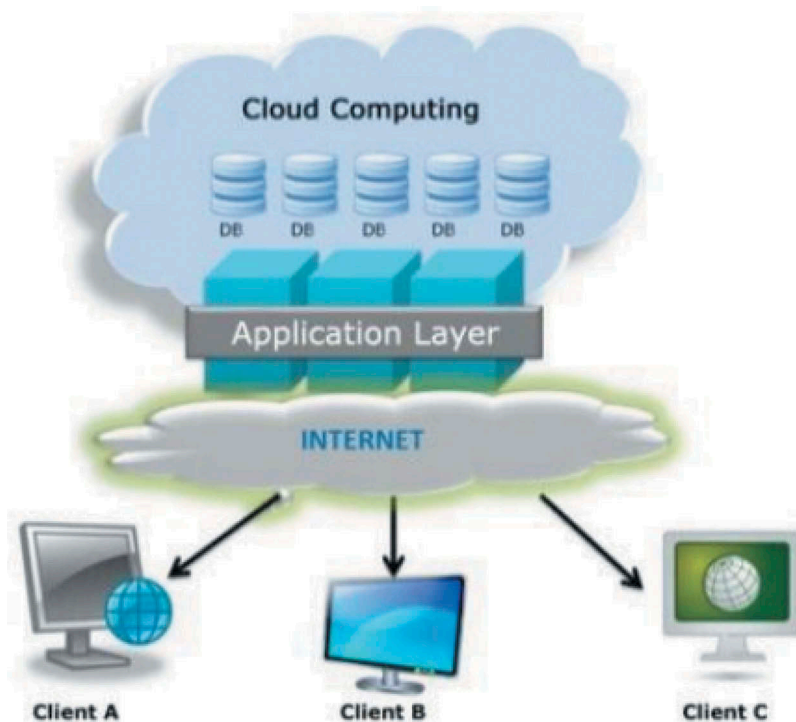
Figure 4. Cloud ERP architecture. Source: (Habadi et al. 2).

and operational business capabilities (such as finance, HR, purchasing, manufacturing and distribution) with appropriate levels of integration that balance the benefits of vendor-delivered integration against business flexibility and agility" (Gartner). In this sense, a postmodern ERP is a more federated, loosely coupled ERP environment with all or most of its functionality sourced as cloud services or business process outsourcers (Guay "Postmodern Erp Strategies and Considerations for Midmarket It Leaders").

According to Guay "State of North Carolina Jloc on It", ERPs have gone through four major phases since the 1980s: (1) best-of-breed between the 1980s and 1990s; (2) monolithic ERPs between the 1990s and 2000s; (3) postmodern ERPs in the 2010s; and (4) a yet unnamed fourth phase that will occur in the 2020s.

Discussion

As demonstrated by the preceding discussion, ERPs have undergone enormous changes over the last six decades. The discussion on the evolution of ERPs reveals differing timelines and the presumption of improvement over time.

First, depending on the chronological period that an author has commented, the naming of the period may differ. Some authors characterize ERPs through the 1990s (Nijher 6). Others characterize through the 2000s (Rashid et al. 4) and the 2010s (Guay "Postmodern Erp Strategies and Considerations for Midmarket It Leaders"). Each of the authors have their own timeline. When timelines are superimposed, they show the rapid change illustrated in Table 1.

Regardless of the terminology, the table suggests, albeit just from naming, that the last six decades in ERP development have been rapid and drastic.

Second, the evolutionary changes within ERPs are built on the presumption that each iteration sought to improve on internal processes within the enterprises in which ERPs are implemented. Nazemi et al. (1000) argued that ERP systems should not be a mere technological artifact. Instead, they are a core platform designed to support and lever the capabilities of the tools and processes used by an organization. According to Callejas and Terzi (1), during the 1980s and 1990s, many organizations invested in ERP systems to replace legacy systems. These were tasked with performing individual business processes contain costs and improve operational performance, efficiency, and internal controls. During the 1990s, ERPs provided cross-functional and enterprise-wide integration to support and embed standard business processes (Bjelland and Haddara 2). Beyond the 2000s the emphasis has moved from internal control mechanisms to leveraging value in real-time (Greengard 1). This evolution is illustrated in Figure 5.

The value-driven evolution is prompted by at least two related realities. On the one hand, most organizations face both diminishing resources and increasing pressure for quality and quantity products or services. This is

ERP IS TRANSFORMING
FROM FOCUS ON 'CONTROL' TO 'VALUE'

4th Generation Augmented Back Office

Combines digital and human workforce via RPA and AI

3rd Generation Platformed Back Office

Focused on commoditized cloud-based systems

2nd Generation Process Led ERP

Standardized to leading processes

Customized only where required

1st Generation Custom ERP

Delivered & customized to 1,000s of client requirements
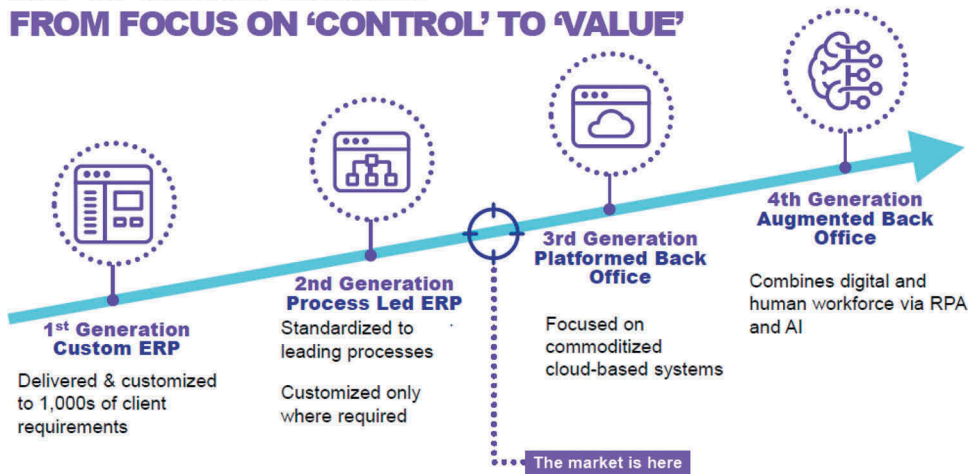
The market is here

Figure 5. Evolution of ERPs. Source: (Howard)

the reality in private enterprise and (possibly even more) in the public sector. On the other hand, the 21st century unveiled digital innovations like robotic process automation (RPA) and artificial intelligence (AI). Figure 5 shows that by 2017, the third phase or ERP transformation would be cloud based and the fourth phase would embrace digital innovations like RPA and AI. Some may see the integration of ERPs with AI and RPA as opportunities. However, organizations that hold back and approach system modernization with a "keep the lights on" philosophy will lose their appeal to customers and citizens (Ward). Nonetheless, the adoption of change requires a validated strategy that aligns with the specific needs of an enterprise (Nijher 5). This must go beyond mere integration of sophisticated technologies. It must impact an institution's operation and execution of a strategy (Lipson and Gauthier 101).

Conclusion

This article briefly demonstrated that ERPs could be understood as both a concept that involves the integration of business processes and a system that, at its core, has an integrated database and several modules that cover various functional areas (Callejas and Terzi 1; Rist and Martinez). ERPs as platforms and concepts trace their genesis to the early years of computing in the 1940s. Their immediate precursors are integrated control (IC) packages of the 1960s, as well as MRP systems of the 1970s and 1980s. Between the 1990s and 2000s ERPs and extended ERPs initially had a monolithic architecture. This moved toward multiple platforms in the postmodern ERPs of the 2010s.

This article highlighted that ERPs have evolved rapidly in response to both internal and external dynamics in the enterprises where they have been implemented. Many enterprises are faced with the challenge of increasing stakeholder and/or customer expectations and diminishing resources to meet those expectations. If ERPs are going to be useful platforms to spur integration and value creation, they must be implemented in a technological ecosystem that acknowledges the overall institutional operations and strategy. Based on this article, it is important for institutions that already have ERPs to consider evolving with digital innovations from single monolithic systems to cloud-based and postmodern ERP systems that integrate with technologies such as artificial intelligence and robotic process automation.

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