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**Digital Technologies Research and Application**
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# Reassessing Critical Success Factors for ERP Implementation in the Digital Era

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**Received**: 16 June 2024; **Revised:** 10 July 2024**; Accepted**: 12 July 2024; **Published**: 22 July 2024

**Abstract:** This paper examines the recent evolution of Enterprise Resource Planning (ERP) systems and explores the critical success factors (CSFs) for project implementation in the digital age. Adopting a qualitative inductive approach, the article first reports on CSFs evident in relevant literature drawn from the past two decades. In the second research phase, interview feedback from nine industry project managers is analysed to identify the CSFs now considered of particular relevance in the digital era. The article concludes that many of the established CSFs remain relevant, but recent research suggests the deployment of digital technologies and the availability of the cloud for ERP operation will mean that CSFs will be re-formulated in new technology and business environments. CSFs related to cloud-based vs on-premise software operation, system configuration and functionality trade-offs, and the integration of digital technologies into ERP products, are likely to emerge in the digital era. Future studies could profitably focus on these largely unresearched aspects of ERP projects, to which this article makes a small contribution that may provide a useful point of reference for subsequent studies.

**Keywords:** enterprise resource planning; ERP; critical success factors; CSFs; digitalisation; project management

## 1. Introduction

The first computer-based information systems were utilized within manufacturing enterprises in the 1960s, when aspects of materials management were automated in the early production planning and control applications, generally termed Materials Requirements Planning (MRP) systems [1]. The Gartner-coined term Enterprise Resource Planning (ERP) followed in the 1980s which built upon the functionality of the early MRP systems and the closely related Manufacturing Resource Planning (MRP II) systems, which incorporated production-line resources planning as additional functionality. These systems allowed an enterprise to manage its manufacturing processes by utilizing scheduling, production planning and inventory control functionality to ensure that materials and components were available at the assembly station as required, along with the required manpower, thereby yielding benefits such as inventory reductions, enhanced effectiveness and efficiency, and an improved customer experience [2]. Subsequent releases of these systems added closed-loop planning functionality, taking capacity constraints into consideration. These operations remained at the core of subsequent ERP systems, which provided support for supply chain management processes, particularly in manufacturing industries [3].

In the 1990s, the advent of the Unix operating system, combined with the emergence of the Intel chipset and the SQL database as the dominant combination in software development, supported the growth of a standardised marketplace for integrated software packages, that had hitherto been prevented by proprietary

hardware and different operating systems. This produced a rapid growth in the up-take of ERP systems and their onward development by major vendors to incorporate new functionality. Software modules were added to these packages to support other business processes, often via the acquisition of competitor products. Financial management, human resource management, plant maintenance and sales and marketing modules were added to the core manufacturing control and planning functions of ERP packages, and connectivity between these modules was gradually improved through new releases of these integrated software packages. From thereon, ERP functionality was increased and improved, and in recent years has benefited from the integration of digital technologies within its main operational areas, notably through the use of analytics and artificial intelligence (AI). This article attempts to track the evolution of critical success factors (CSFs) for ERP project implementation over the past 25 years, and reflect on the new challenges ushered in in the digital era. In this context, this article addresses the following research questions (hereinafter referred to as RQs):

RQ1. What are the main CSFs for ERP project implementation highlighted in the extant literature?

RQ2. How do project managers view the key CSFs and barriers to successful ERP project implementation in the digital era?

Following this introduction, Section 2 provides a brief review of pertinent literature. Section 3 then details the research methodology used in the study. In Section 4, the CSFs that have emerged through the experiences of ERP project implementation in recent decades are discussed, as documented in the academic literature and consultancy reports. The perspectives of project managers involved in ERP project implementation are then examined through interview feedback from nine industry project managers. The discussion section assesses these findings in the context of recent literature that focuses on the interaction of ERP projects with digital transformation, and how this may impact the debate around CSFs. Finally, Section 6 provides a conclusion to the study, which highlights the main outcomes from the research, discusses its limitations, and outlines possible future avenues of the investigation.

## 2. Relevant Literature

Close to the turn of the century, as companies were increasingly turning to ERP systems as the core component of their corporate information systems strategy, Deloitte [4] provided a three-point framing of an ERP system, which still holds good today. They noted that an ERP system could facilitate the integration and automation of most business processes; underpin the provision of accurate data across the organization; and provide cross-company access to this data from one central database in real time. Davenport [5] also emphasised the integration aspects of an ERP system, supporting all the information flowing through a company, such as information pertaining to accounting, customer services, human resources and financial functions. Other authors pointed out that the implementation of an ERP system is best served by a structured and controlled project management approach [6,7]. Based on an underlying database, providing "one version of the truth", ERP systems were often the catalyst for major process change and implemented as part of business process re-engineering initiatives, that steered companies towards adopting more standardised business models. ERP was considered by some as a necessity and was seen as "the price of entry to running a business" by Kumar and Van Hillegersberg [8]. Despite the increase in the breadth of the application of these packages, some business functions and business processes remained outside the scope of these systems, such as product life cycle management for shop floor product development [9], although the major ERP vendors continued to expand their product functionality to reflect market demand. SAP, Oracle, Microsoft and more recently Sage, Infor, and Epicor emerged as major players in the ERP marketplace.

With the advent of the Internet, web-enabled versions of ERP systems were developed, facilitating inter-organizational collaboration across the extended supply chain. The integration of ERP systems with various other business systems inside and outside the organization is now a norm and viewed by some as a prerequisite for business success in the digital era. Garg and Venkitakrishnan [10] identified that the organizational benefits included reducing overheads in a number of areas: planning cycle time, manufacturing cycle time, inventory, requirements for manpower, and errors in ordering. Other benefits included a faster response to changing market conditions, increased customer satisfaction, elimination of redundant data, and better utilization of resources, as well as easier access to reliable, integrated information. ERP systems provide the means to utilize the available information to improve quality, diversify products and services, reduce inventories, and keep down

costs in the supply chain, to stay ahead in a rapidly changing business environment. Today, an ERP system has become "an indispensable infrastructure for many dominant organizations that will expand the extent of integration to reinforce business processes" [11], but the proclaimed benefits have changed little over the past two decades, even if their manifestation is somewhat different in the digital era. Gill [12], for example, recently observed that "one of the key benefits of working with a cloud ERP is that it allows you to integrate all different departments, functions, and line-of-business apps into one cohesive platform. Then, you can use data from across that entire ecosystem to design processes that align with specific goals", and added that benefits included "improving productivity, cutting costs, enabling cross-functional collaboration, or leveling up your data strategies." The same could have been said of ERP products twenty years ago.

Disadvantages have also been identified and documented. The limited scope to customise the ERP software can result in the forced reengineering of business processes to fit the "industry standard" process model upon which the ERP system is built, which might, in turn, lead to a loss of competitive advantage. ERP systems embody "best practices", which represent the underlying assumptions, beliefs and the way of doing business of the software vendor, with the system "imposing its own logic on a company's strategy, organization and culture" [13]. A further disadvantage has been termed the "weakest link" problem—inefficiencies in one department may result in poor quality data that is used by other departments working with the provided information [10]. The complexity and dependency of implementation issues led to significant failures in the early years of ERP project implementation. The total failure rate was estimated to be as high as 40%–60% [14], with failures of implementation projects leading to problems as serious as organizational bankruptcy [15].

The development of the Internet and cloud-based computing has ushered in new versions of ERP packages that run, not on company premises, but in the cloud. Software as a Service (SaaS) gives customers the option of using the provider's software application on their cloud infrastructure [16], providing potential benefits of lower costs, and easier maintenance and upgrade processes. At the same time, the deployment of digital technologies (particularly AI and analytics) now underpins the concept of "intelligent ERP", which IDC [17] defines as "applications or suites that use machine learning and advanced analytics built on a large, curated data set to forecast, track, learn, route, analyze, predict, report, and manage these resources and business processes." ERP products have also been enhanced by "extensibility" options which SAP [18], for example, sees as "a key capability", which "enables customers to create a competitive advantage by customizing their business processes……with tailor-made solutions." Nevertheless, there are also drawbacks here that mirror those associated with customisation of the early ERP packages in the 1990s. As regards SAP, Gupta [18] points out "although, being very powerful, flexible, and popular, classic extensibility has some major drawbacks. One of them is high upgrade efforts. The missing clear interface between SAP code and extensions might lead to issues in the extensions during upgrades. As a result, upgrades require high planning, regression test, and adaption efforts, which is one of the reasons why customers delay upgrades."

Nevertheless, the convergence of ERP project implementation and digitalisation is generally viewed as a step change in how information systems and process change can make a positive impact on company efficiencies and operations. Slimov [19] noted that "ERP has a major impact on digital transformation. It has the capability of bringing revolutionary changes in various processes of modern business". Within this context, project managers are having to deal with new problems and a reworking of old issues in the implementation and/or upgrade of ERP systems modules. CSFs, first introduced by Rockart [20] for information systems planning, are a well-established approach to project management. Bullen and Rockart [21] subsequently positioned CSFs as a means of assessing project outcomes and achieving project goals. This approach thus remains of relevance today in this rapidly evolving technology and business environment.

## 3. Materials and Methods

The research adopts an interpretivist paradigm and an inductive approach, in which the aim is not to provide conclusive solutions, but rather a better understanding of the problem, forming a base layer for further, more conclusive research in due course. This is a qualitative study, which aims to assess how humans experience and feel the impact of the phenomenon under study—in this case, the implementation of ERP projects.

The research method comprised two distinct phases. First, an initial scoping review identified CSFs for ERP project implementation noted in the extant literature. This provided an initial conceptual framework which

allowed the design of the semi-structured questionnaires and interviews with industry-based project managers in November 2021. All respondents were based in the Middle East but have worked around Europe and parts of Asia. An initial questionnaire was issued to the interviewees, followed by an interview of approximately 30 min, to clarify responses. The interviews were undertaken via Skype or in person.

The interviewees (Table 1) had varied experience of implementing ERP systems in both the cloud and on-premise environments. P1, for example, stated that initially ERP systems were implemented on-premises, "but later we implemented cloud-based systems just for HR and marketing processes. We also subsequently implemented business intelligence software". In a similar vein, P7 noted, "We have dedicated teams for both (on-premises and cloud), and we recently implemented a cloud system for Business Warehouse and Business Intelligence". However, several of the project managers interviewed had only on-premise experience, with P6 noting "I specialize in on-premise systems and many of the people in my team also specialize in on-premise projects. Very few have worked on cloud-based systems". The questionnaire and follow-up interviews focused on critical success factors and barriers to successful ERP project implementation. Analysis of this material was achieved manually via scanning of the material and allocating specific passages to the main themes that emerged, which largely corresponded to concepts identified in the literature review.

**Table 1.** Project manager interviewee profiles.

| Project Manager | ERP Project Size (Large/Small < $1 million Budget) | ERP Project Environment (On-Premises/Cloud) |
|---|---|---|
| P1 | Large | Both |
| P2 | Large | Both |
| P3 | Large | Cloud |
| P4 | Small | On premises |
| P5 | Large | Both |
| P6 | Small | On premises |
| P7 | Large | Both |
| P8 | Large | Both |
| P9 | Large | Both |

A qualitative study with just nine interviewees does not seek generalisability or only to a very limited extent. Rather, the analysis of a variety of factors provides new insights and hence the creation of knowledge of the studied phenomenon. Instead of achieving statistical generalisation, which is the objective for quantitative researchers, a qualitative research design focuses on what Yin [22] refers to as "analytical generalization". It aims at the transferability to similar contexts and situations. As pointed out by Islam and Aldaihani [23], qualitative research does not normally include a large sample of a population because the collected data is not quantifiable. A small but relevant sample of participants can provide data until a point of saturation is reached. Saturation is understood by Hennink and Kaiser [24] as "the point in data collection when no additional issues or insights are identified and data begin to repeat so that further data collection is redundant, signifying that an adequate sample size is reached". According to Bowen [25], "saturation is reached when the researcher gathers data to the point of diminishing returns when nothing new is being added". The authors believe that the nine interviewees provided enough data encompassing various perspectives on the CSFs identified in the literature to suggest a degree of saturation was attained.

## 4. Results

This section addresses the two RQs noted in Section 1, first, examining the CSFs that are prominent in the extant literature, stretching back to the turn of the century when the first research reports on this subject were

published (Subsection 4.1). The recent perspectives provided by nine project managers with experience of ERP project implementation are then assessed in Subsection 4.2.

### 4.1. What Are the Main Critical Success Factors (CSFs) for ERP Project Implementation Highlighted in the Extant Literature (RQ1)?

CSFs for ERP projects have been identified for on-premises implementations in a number of sources over the past two decades [26 – 28]. CSFs have also sometimes been attributed to different phases in a project — typically pre-implementation, implementation and post-implementation [29] (Figure 1), with some authors [30,31] focusing specifically on the post-implementation phase, which it is suggested, has received less attention in the literature to date. There are many CSFs identified in this literature, Ahmad et al. [32] alone having identified 33 CSFs, and only a flavor of the most researched CSFs is reported here.

Amongst the CSFs highlighted in the literature as a whole, Kraemer [33] pointed out the importance of having alignment of business strategy with ERP functionality, and the value of strategy flexibility and adaptability in achieving such coordination. The business has to have a compelling vision as well as clear definitions of goals, expectations, and deliverables, defining the rationale for the ERP project and what business needs will be addressed. This, for example, is evidenced in two case studies of ERP projects undertaken in 2007 [34] which concluded that "first and foremost, business leadership and commitment are essential. This is probably the single-most important factor in ensuring project success".

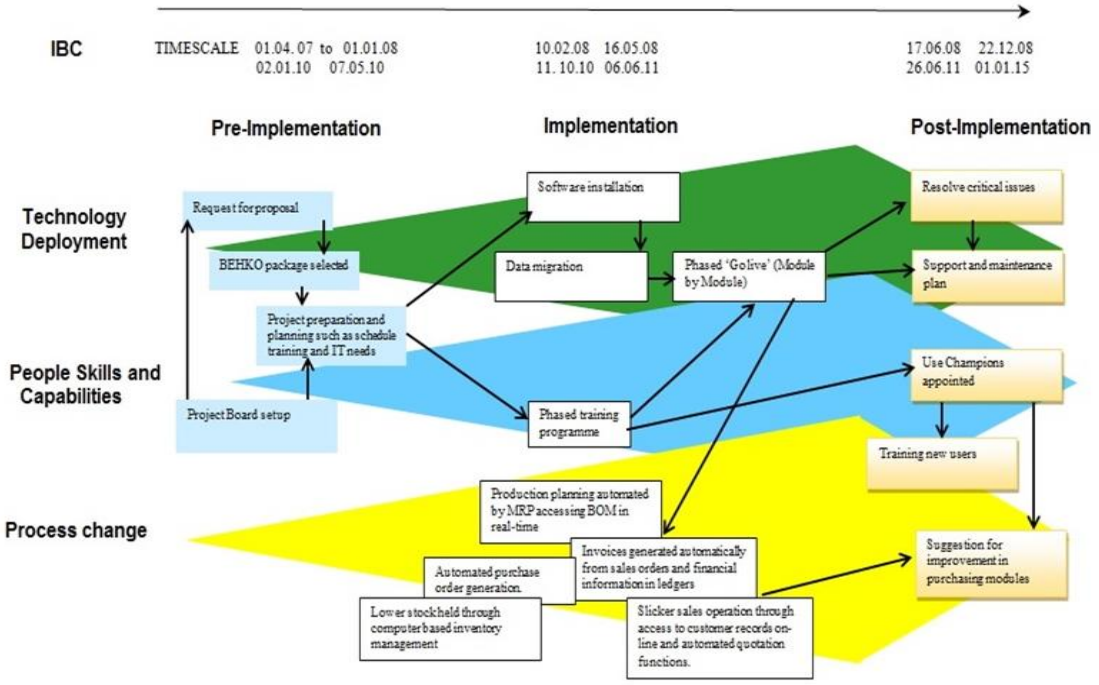


**Figure 1.** The three phases of an ERP project in a manufacturing industry case study. Source: Rezaeian and Wynn [29].

Masood and Farooq [35] suggest that agile project management techniques provide a solution to the problems in traditional management methodologies experienced in dynamic project environments, when there are a wide variety of stakeholders. Kalaimani [36] also discussed how agile project methodology can be used to adjust to the rapidly changing business environments during SAP ERP implementations, and how these shortcomings and pitfalls can be accommodated by utilisation of agile techniques and processes. Kraemer [33] further identified the factors contributing to ERP system implementation and utilization failure. These factors included insufficient planning before technology acquisition, lack of user training and involvement, problems with budget allocation and scheduling, and the availability of suitable skills, all of which are important in determining ERP success and failure. Indeed, the availability of adequate resources is a recurrent theme in the literature. This was evident in a case study of ERP project implementation at Dowty Propellers [34], an aircraft

manufacturer SME: "one major issue that put the project in jeopardy was the competition for resources due to the large number of projects currently going on…., in which input from the same people was required". Effective system integration to enhance system connectivity and alignment of data and processes was identified by Beheshti et al. [37] as a further success factor.

Successful ERP project implementation will also require a critical mass of knowledge by the employees to enable them to work and solve problems within the system, so they will not invent their own workarounds outside of the ERP solution. Umble et al. [38] observe that "reserving 10%–15% of the total ERP implementation budget for training will give an organization an 80% chance of implementation success". In a study conducted by Herath [39], 4 companies from the fast-moving consumer goods (FMCG) sector that had already implemented ERP systems were researched via practitioner interviews. Evaluating the feedback, Herath [39] identified the success factors under four main headings — "technology knowledge level", "management commitment", "government regulations" and "implementation experience". In a similar study of ERP projects in the manufacturing industry, Beheshti et al. [37] concluded that effective project management and the cultural adjustments which need to be made to integrate the new system and its processes in the organization's corporate framework were critical to overall success.

In cloud-based environments, the implementation process and the underlying CSFs are not well-researched [40]. However, several authors [41,42] have pointed out substantial differences in the ERP implementation approach, the adaptation of the software to the customer needs via customisation, the availability of extensibility options, as well as multiple other aspects of cloud-based systems operation. SaaS may provide a quick-to-implement, easy and cost-effective alternative to conventional on-premise ERP solutions [43,44]; but the aforementioned literature also concludes that a SaaS solution differs from conventional ERP solutions in that the entire implementation process, the project design, and technology deployment are all quite different to on-premises projects.

Nevertheless, recent research has continued to identify and discuss a similar range of CSFs for ERP projects, both cloud-based and on-premises. Georgiev [45], in his analysis of previous literature on CSFs for ERP implementation, concluded that the "five key factors for success" were: "support and dedication of the managers; team skills and abilities; change management/reengineering of business processes; communication and cooperation between departments; and project management and tracking of results". Similarly, Butarbutar et al. [31], having reviewed relevant literature on CSFs, concluded "we successfully pinpointed 13 CSFs relevant to ERP post-implementation and grouped them into the Technology-Organization-Environment (TOE) framework. The three most pivotal CSFs emerged as continuous system integration, post-implementation training, and active user participation". The significance of user participation was emphasized by Strutner [46] in her analysis of three recent case examples of ERP projects. She concluded the key success factor was "employee adoption and morale, which requires encouraging buy-in by presenting the ERP in a way in which it will directly benefit the end users". Kusumawardhana et al. [47], in their study of ERP implementation in the Indonesian social insurance sector, reported that "this study revealed 15 success factors, categorized into organization, process, and technology dimensions. ….. among these, five CSFs stood out: project team competence, vendor and consultant quality, ERP fit, top management support, and hardware and software selection". Salih et al. [48] analysed on-premises ERP systems projects in two manufacturing organizations in Saudi Arabia, identified seven critical success factors, and explored the relationship between them. Using regression analysis of responses to questionnaires from 177 end-users, the authors found that "the impact of top management support was significant on user training, competency of internal Information Technology (IT) department, and effective communication between departments, but insignificant on continuous vendor support. Meanwhile, continuous vendor support had a significant influence on continuous integration of the system, but was insignificant on user interfaces and custom code". Ogedengbe and Idolor [11], in their study of ERP projects in the Nigerian telecommunication industry, found that "business plan, financial resources availability, employee support and business process re-engineering have an absolute effect on the implementation of the software suit". In their recent analysis of major ERP projects at Nestle, Cisco Systems and Hersheys (involving SAP and Oracle ERP systems), Eastgate [49] concluded "the success of an ERP transformation is contingent on strategic planning, adept management, appropriate training, and stakeholder buy-in", adding that "avoiding over-customisation" was a "critical consideration".

### 4.2. How do Project Managers View the Key CSFs and Barriers to Successful ERP Project Implementation (RQ2)?

The interviewees, drawing upon their own experience and industry knowledge, put forward a range of issues they considered critical for successful ERP project implementation. These covered factors pertaining to strategy, management support, training and testing, and financial and human resources.

Some interviewees highlighted the importance of an ERP implementation being set within an overall business strategy, not least because of the massive cross-company implications of such projects. P2, for example, noted "strategic planning is important before you decide what to do as it gives the right direction to invest", and P4 noted that "management must have a clear vision". In a similar vein, P8 maintained that "first, there should be a clear vision and key performance indicators (for the project)".

Closely related to this issue is the need for support from senior management. P1 emphasised that "higher management support is very critical" and that "without that we struggle to even get basic things done". P9 opined that "higher management support is critical", and P8 suggested "first, secure the executive support, and then plan your future system accordingly".

The package selection process was also commented on. P3 highlighted "active user involvement" in the selection process as a CSF. P6 pointed out that "to have an experienced solution architect so that the system selection process is smooth and doesn't give any problems later on regarding the feasibility of the system" was of importance. P4 added that "good infrastructure design" was a key issue and P7 put forward that "understanding what the client wants—the complete requirement is very important; and even before that, system selection is the key". P3 similarly observed that "solution design must be well researched and consulted from all stakeholders which brings us to good communication between all stakeholders".

Indeed, effective communication was also raised at several levels. P8 concluded, "finally, I cannot ignore the importance of good communication between client and partner teams", and P1 maintained "there should be proper protocols and points of contact on both the client and partner side, otherwise bad communication can be a destroyer". Then, at the project team level, P3 stated that "good communication with my team" was a key issue, and P4 also noted the value of "good and regular communication". P9 emphasised the value of a quality project team: "motivating my team and keeping them well connected is the key, but of course before that, a good project plan needs to be formulated".

Several respondents also drew attention to the significance and necessity of system user training. P9 noted, "user training and proper involvement is really important: those who have to use the system must be well prepared". P9 elaborated that "the training of core users is even more important than power users". P5 similarly asserted that "detailed user training is important for system utilization" and suggested the need for "multiple user acceptance testing sessions and a strategy for user adoption". P6 also noted that "user acceptance testing or UAT is very important—if the system is properly tested in each phase, it will be easier for both the users and the consultants. But sometimes users don't give time for testing and later on complain that the system has not been implemented as they wanted". This touches on the thorny issue of system handover to user ownership and in this context, P2 advised, "invest wisely in a system which your employees will accept", warning that "without acceptability, the system will fail".

The issue of customisation (i.e., asking for changes in the way the ERP package operates) vs configuration (setting switches in the software) was also raised. P1 observed that "I always advise the client to follow standard best practices that have been researched to give best results", adding that "many solutions like Oracle HR gives us a best practice configured process beforehand. It is always better to follow standards rather than to dive into customisations". P4 similarly advised "sticking to standardisation, as customisation makes things very difficult in the future". In this context, the need for process change was recognised and P7 highlighted the need to "give HR the authority to plan for change management beforehand".

When specifically asked about barriers to successful implementation, some of the responses were a mirror (negative) image of the CSFs. Lack of support from senior management was arguably the major concern. P5 pointed out that, "lack of higher management support, even after implementation, can lead to systems failure", and P3 listed "lack of management support and simultaneously resistance to the change management process" as barriers to success, adding "these two are linked, as with management support, change management is easy". P4 highlighted "lack of support from the higher authority during implementation — also lack of resources

sometimes". Indeed, inadequate skills and resources were another recurrent theme. For example, P1 noted that "sometimes we have everything except good resources to implement it (the ERP project) as per the client requirement, and so we are bound to fail", whilst P2 identified "an inexperienced project manager who doesn't know what to do" as a key cause of failure.

The significance of good and effective communication again surfaced as a key issue, notably linked to requirement analysis. P9 highlighted the "lack of communication and an ineffective requirement gathering phase" as key barriers to success, and P6 noted "incomplete requirements for sure because it really puts the implementation in the wrong direction". P7 similarly identified "not listening to the client — not enough communication and not frequent communication". P8 summarised key failure points as the absence of a "clear vision and KPIs (key performance indicators); right investment in the right system and also at the right time; and good communication between client and partner teams".

As regards project management methodologies, there was no clear support for any type of methodology, and the overall impression was given that the methodology used was not of critical significance. P3, for example, noted, "we mix and combine methodologies", and P1 said "I have no preference because the methodology is not a key issue as compared with my own experience", although P3 added that "when it comes to SAP ERP or cloud implementation, we go for their (SAP's) own ASAP methodology which is a combination of many other methodologies". P4 conceded "Waterfall ..... is my preferred (methodology)", whilst P5 stated, "we prefer agile". P8 maintained that the choice of methodology was of no great consequence, and "project methodology ..... is not relevant to (project) success". Although this is only a snapshot of 9 project managers, this suggests that there is no great preference for agile over more traditional project management methodologies, and that the advent of cloud-based ERP projects has had no major impact on project management preferences.

In summary, there is no universally agreed prioritisation of CSFs for ERP projects, and no clear dividing line or allocation of CSFs to the different implementation stages, nor is there a differentiation between CSFs for cloud and on-premises projects. Nevertheless, a subjective assessment of the available literature and a review of the interviewees' perspectives suggest that seven main CSFs are of particular significance across the ERP project phases: top management support; business strategy alignment; user involvement and training; avoiding software customisation; continuous process change; the necessary project management skills and resourcing; and effective communication at all levels.

## 5. Discussion

The above findings raise some issues worthy of further discussion. Firstly, the interviews suggest that the general perception of CSFs and barriers to successful ERP project implementation in the recent past is not radically different from that which surfaced in the early years of ERP package implementation. For example, as regards project management methodologies, Wynn and Rezaeian's study [50] of the implementation of the Infor and EFACS ERP systems in two manufacturing companies in the UK found "it is not necessary to follow any specific project management methodology closely — in a manufacturing SME, only selected elements of these methodologies are likely to be appropriate", a sentiment echoed by the majority of interviewees in this study. Similarly, the authors observed that it was "crucial that employees understand the rationale for the new ERP system and feel a shared ownership of both the new system and the project". The need for in-depth training, user acceptance testing, top management support and good communication have also featured as key issues in ERP project reviews for more than two decades [51].

Secondly, however, some CSFs are evolving in their form and application as digitalisation impacts organisations and the scope of ERP projects. Process change may now appear less critical than hitherto, when ERP packages were less flexible and user companies had to adopt and adapt to the underlying business model upon which the ERP system was designed. On-premises ERP systems are now more flexible with a wider range of configuration options, and many companies have become used to the need for on-going process improvement, following the business process re-engineering focus of the 1990s, and more recently the need for process flexibility initiated by digitalisation. Just before the turn of the century, Koch et al. [52], reflecting on the scale of process change required by ERP projects, concluded that "the inherent difficulties of implementing something as complex as an ERP is like teaching an elephant to do the hootchy-kootchy", and Turban et al. [53] similarly emphasised that "with the advance of enterprise-wide computing comes a new challenge: how to control all

major business processes with a single software architecture in real-time". 25 years later, however, as ERP and digitalisation projects overlap in some organisations, the nature of process change to accommodate a new ERP system will be increasingly intertwined with digital technology deployment (Figure 2). This is particularly the case when the deployment of digital technologies brings about significant change in company products and/or services. A recent study of the German automotive industry [54] concluded that "when this happens, digitalisation becomes digital transformation, sparking significant additional change in business processes and people competencies, that may in some cases constitute the transitioning to a new business model". In this context, Gill [12] recently coined the term "ERP digital transformation", which he saw as "the process of integrating advanced digital technologies into an ERP system to enhance capabilities, streamline processes, and improve overall efficiency. This transformation involves adopting cloud-based solutions, utilizing artificial intelligence and machine learning, and leveraging data and analytics". This aligns with the concept of "intelligent ERP" or "iERP" in which the majority of the digital technologies can be deployed or are integrated within the ERP software suite [17].

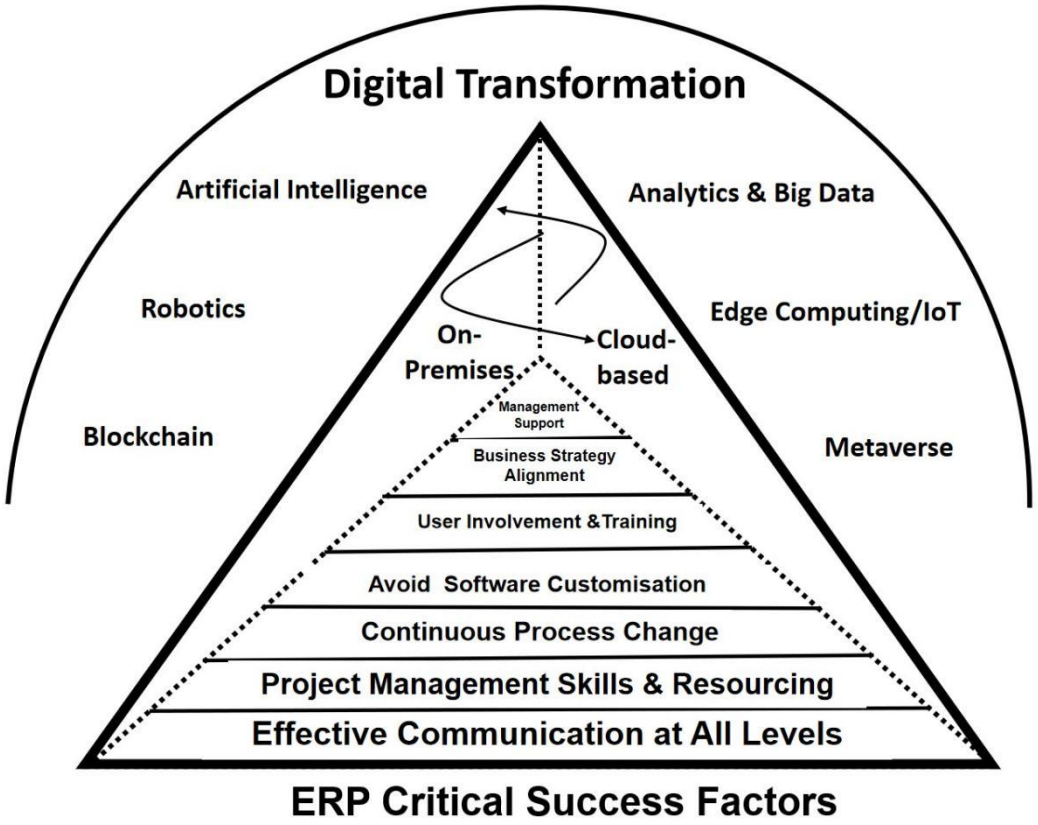


**Figure 2.** ERP CSFs in the digital era.

Thirdly, cloud computing has ushered in new options regarding the establishment and operation of ERP systems that will bring new success factors to the fore. All major ERP software developing companies have introduced extensibility functions for their on-premise solutions via cloud platforms to reflect changes in mainstream business requirements [55,56]. These cloud platforms provide customers with the three standard service models of cloud computing: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and SaaS. SaaS ERP solutions are most in evidence, providing customers with the capability of using the provider's software application on its cloud infrastructure, and are, as cloud applications, structurally independent of PaaS products or technologies [57]. PaaS can be used to extend SaaS ERP solutions to support business processes [58], which are not part of the SaaS-delivered functionality. The platform options and combinations, and their associated costs and benefits, have now become a key issue in ERP project implementation. Some evidence suggests the cloud-based options, ironically, originally provided less scope in terms of process flexibility compared with on-

premises implementations, but major ERP players have now introduced low-code application platforms (LCAPs) which allow ERP users to develop their own product customisations. Gartner [59] defines LCAPS as "application platforms that are used to rapidly develop and run custom applications by abstracting and minimizing the use of programming languages" which can "provide features essential for application delivery and maintenance in midsize and large organizations". They add that "LCAPs are the foundation for a wide range of application types, application components and process automation". These developments will likely impact the perceived criticality of avoiding customisations, and also increase the scope for process flexibility in the ERP project implementation in the future.

Fourthly, issues regarding data consistency and maintenance have evolved and been reformulated. Hitherto, a major benefit of implementing one integrated software package (the ERP system) for most business areas was that data consistency would be enhanced through a more controlled and simplified data maintenance process. Nevertheless, as detailed case studies have shown, "ERP systems rarely provide 100% of the functionality required, and some interfacing to old systems or new point solutions is normally required" [34]. This produced concerns around data quality because of the continuation of multiple maintenance of key data items via legacy systems. Now, however, although these concerns may remain, they have been compounded by a range of digital devices introduced in digitalisation initiatives, some of which provide data capture for ERP processing, and some of which remain standalone technologies. In this context, Gill [12] recently observed that, "ERP systems use an abundance of different technologies, including cloud computing, artificial intelligence and machine learning, and data and analytics. ERP systems also utilize the Internet of Things (IoT) for real-time data collection, mobile technology for flexibility, blockchain for security, and process automation to reduce errors". The old image of silos of non-connected data in legacy systems has been superceded and left behind, as digitalisation has ushered in new digital devices that may or may not be connected to the underlying ERP database, which may be prone to cybersecurity vulnerabilities. The rapid uptake of digital technologies, such as Big Data, robotics and IoT, has provided new challenges for ERP technology integration, data integrity and cybersecurity.

This is of particular relevance in companies where the ERP product has not been implemented in all process areas, where interfaces between the ERP product and remaining legacy systems are still in place. This is the case in many enterprises and may be the result of a phased implementation strategy, in which the ERP product modules are implemented in stages over a number of years and new interfaces built as needed. For example, this form of implementation (an alternative to the "big bang" approach) was pursued at the Waha Oil Company [60], where SAP modules were introduced for Sales and Marketing, Human Resources Management, and Financial Management. However, legacy technologies were left in place in other process areas (Figure 3). Such a profile of the current system portfolio is not unusual and brings new problems to companies in this position in terms of integration and data quality as digitalisation is progressed. In this context, the role of Application Program Interfaces (APIs) has been much debated as a possible remedy for such integration issues. Some technology companies position APIs as a solution for integration challenges. Google Cloud [61], for example, suggests that APIs are critical components of successful digital transformation and the integration of digital technologies and systems applications. Others, however, express concerns that the proliferation of APIs may increase cyber security risks, whilst many IT practitioners remain unconvinced. For example, Wynn and Lam [62], in their study of digitalisation in major hospitality companies, found that some senior IT professionals expressed the view that APIs "could provide effective integration between digital technologies and applications, but there was no overall consensus amongst the six interviewees on the value of APIs as an integrative tool".

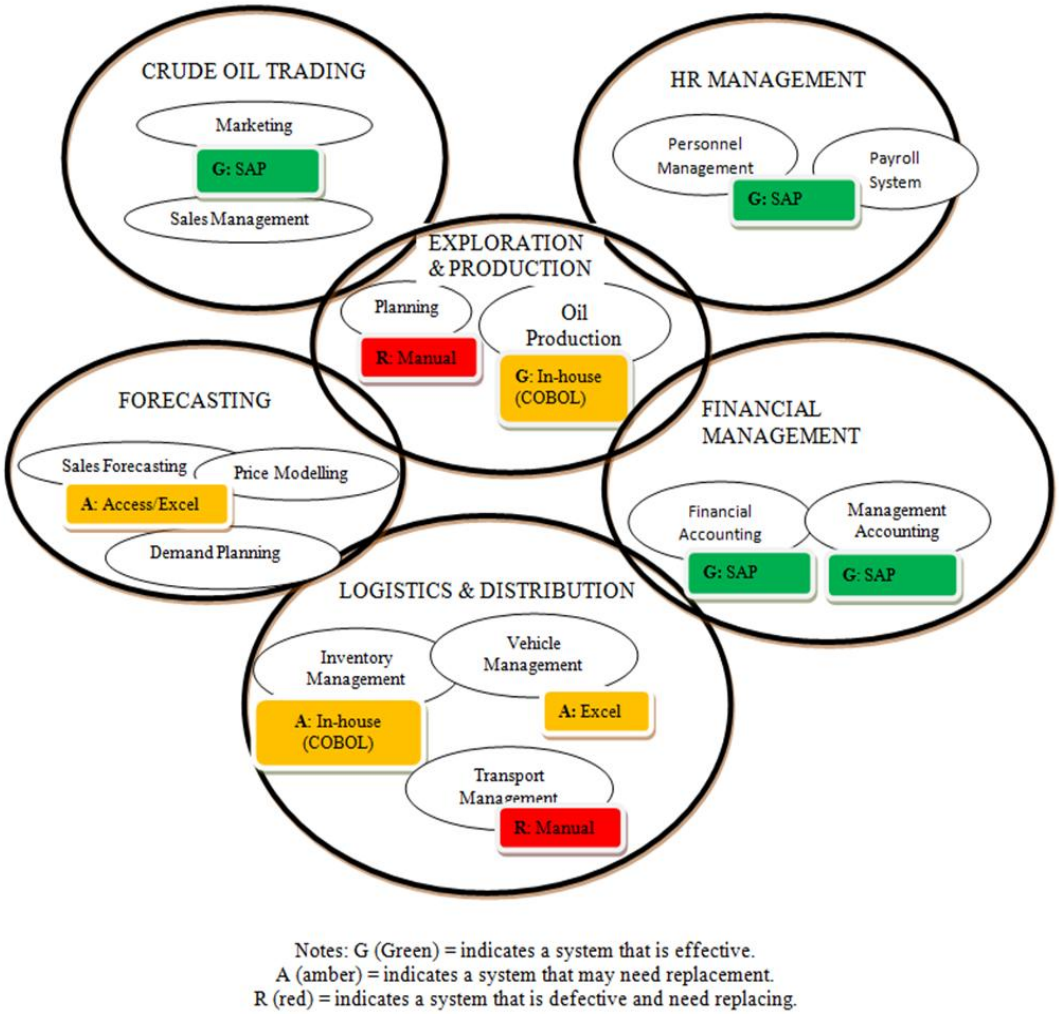


**Figure 3.** Phased implementation of the SAP ERP product at the Waha Oil Company, Libya. Source: Akeel and Wynn [60].

## 6. Conclusions

As the next generation of ERP systems is brought to market, infrastructure landscapes transition from single, monolithic systems to an array of environments, both in the cloud and on-premises. In many organisations, functionality will increasingly be deconstructed into a number of applications—being run and developed on SaaS and PaaS platforms. This change in architecture requires a revaluation of ERP's technical implementation aspects. When planning for the implementation of a large-scale IT project, such as ERP, the IT infrastructure of an organization may need to be radically amended for cloud-based operation. The new system being implemented will have its own processes and protocols which will often replace legacy systems and processes. This rapid change in processes and infrastructure may also cause and/or require a cultural shift in the organization. Current organisational hierarchies may need to transition to align with remodeled processes instigated by ERP system capabilities and digital technology deployment. In this rapidly evolving technology and business environment, it remains pertinent to attempt to distill the CSFs for effective ERP implementation. This article has attempted to address this challenge and set well-established success factors within the context of digitalisation and associated change within organisations. To this point, Gill [12] asserts that "ERP plays a critical role in digital transformation by enabling organizations to streamline processes, leverage emerging technologies, drive innovation, and adapt to changing market dynamics. It acts as a catalyst for organizational growth and success in the digital age".

This research clearly has its limitations in that it is based on an assessment of secondary sources and just nine project manager interviews, and findings inevitably are subjective to some degree. The authors nevertheless believe that this discussion may provide a starting point for subsequent studies that will examine how CSFs for ERP projects are evolving and being reformulated in the digital era. The advent of "ERP digital transformation" and "iERP" will inevitably bring in new perceptions of the CSFs for successful ERP project implementation, but use cases and academic research in this area remain limited at present. Future research could thus profitably explore and document case examples of cloud-based ERP implementation and lessons learnt to date as regards a re-evaluation of CSFs. The differences in the interaction of digitalisation with ERP project implementation within the different process areas within organisations is another fertile ground for future research. Edge computing, for example, will play an increasingly significant role in the widespread use of IoT systems in production [63] and the implications for materials management and production line monitoring functions within an ERP system, where the fore-runners to modern ERP systems started in the 1960s, will again require new research and analysis. The increasingly wide deployment of digital technologies will require continuous reassessment of the implications for successful ERP project implementation.

## Author Contributions

Conceptualization, M.W., B.M., J.I., O.F.I. and H.B.; methodology, M.W., B.M., J.I., O.F.I. and H.B.; validation, M.W., B.M., J.I. and O.F.I.; formal analysis, M.W., B.M., J.I. and O.F.I.; investigation, M.W., B.M., J.I., O.F.I. and H.B.; writing—original draft preparation, M.W., B.M., J.I., O.F.I. and H.B.; writing—review and editing, M.W.; visualization, M.W. and B.M.; supervision, M.W. and B.M.; project administration, M.W. and B.M. All authors have read and agreed to the published version of the manuscript.

## Funding

This work received no external funding.

## Institutional Review Board Statement

Not applicable.

## Informed Consent Statement

Not applicable.

## Data Availability Statement

The key data from participants included in this study is contained within the article. All interviewees are anonymized, so further details cannot be made available because of assured confidentiality.

## Conflicts of Interest

The authors declare no conflict of interest.

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