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Cloud-Based ERP Construction Process Framework in the Customer's Perspective

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Abstract. Process frameworks for the implementation of cloud enterprise resource planning (ERP) were derived and each process was examined through detailed comparisons with on-premise ERP construction processes, using process engineering characteristics. The process frameworks for implementing cloud ERP are classified into infrastructure-as-a-service (IaaS), platform-as-a-service (PaaS), content-as-a-service (CaaS), and software-as-a-service (SaaS), depending on the construction type, and are defined based on 6 derived processes, 21 activities, and numerous specific tasks. The process engineering characteristics of the final proposed process framework were further analyzed and examined in comparison to on-premise ERP construction processes with respect to differences and similarities. This study provides a theoretical foundation of standardized research on cloud ERP construction methods. As a practical guideline for stakeholders, it can be used in practice as a process tailoring tool, providing information on specific activities and tasks for each construction phase, contributing to the construction and spread of reliable cloud-based ERP systems from the customer's perspective.

Keywords: Cloud ERP, ERP comparison, SaaS ERP, CaaS, PaaS, IaaS

1. Introduction

Enterprise resource planning (ERP) is a system for the integrated management of business processes of a company and refers to a commercial software package [1] that supports management in an integrated manner, in real-time. ERP usually integrates main business activities and increases the value of the business process operation performed by all business functions [2,3]. The integration of business processes through ERP ensures information integrity, and falls into the software category of corporate organizational data management [4]. An ERP system can facilitate information flow by automating activities between all business functions within the organization by combining internal and external management across the organization [5].

ERP software can be installed locally on computer hardware built in-house by the company and on user personal computers, depending on the construction type [6]. Regardless of the installation, most ERP software are classified into on-premise ERP and cloud ERP. The former refers to a traditional ERP system construction method where the maintenance of servers or software, such as manual upgrade and update, are performed by the owner company, and the latter refers to a system hosted by the cloud vendor that provides all services [4]. In recent years, most experts identify the cloud ERP as being the future of business technology [7]. In a 2021 ERP report [8], 53.1 % selected cloud ERP, and according to Forbes [6], cloud computing spending has grown at 4.5 times the rate of IT spending since 2009. In the 2018 ERP report of Panorama Consulting [9], 85 % of ERP systems adopted are SaaS or cloud-based ERP systems. In the "Best ERP Software Vendor Companies Comparison 2021" by SelectHub [10], the top 10 ERP leaders among 125 products are Oracle JD Edwards EnterpriseOne, SAP business ByDesign (ByD), sageX3, SYSPRO, Microsoft Dynamics 365 ERP, Infor Syteline, Oracle Suite, EPICOR Kinetic, and IFS Applications from top to bottom in ranking.

Cloud computing is typically divided into the following models according to the construction type. The model is classified as IaaS when only the computer infrastructure is leased, as PaaS when the vendor hosts all infrastructure and programming tools for the implementation of web-based application programs, and as SaaS when the costs are paid for the software hosted by the vendor [5]. In terms of deployment models, three-quarters of the organizations that chose cloud ERP are using the SaaS model [8]. Cloud computing ERP is a hosting service provided through the Internet [5], whereas, the ERP system in the SaaS model resides in the cloud and provides computing functions to run the ERP system.

SaaS Model refers to the application hosted as a service, and the user can access the application through Web-based software in the browser without installing or maintaining any software [26]. Therefore, cloud-based ERP construction and SaaS ERP have different ranges of meaning. Saas ERP is considered a service within a SaaS model. By contrast, cloud-based ERP refers to a cloud computing-based ERP service, among which IaaS, PaaS, and SaaS service models are included. Herein, this approach is referred to as cloud ERP or cloud-based ERP.

Drawbacks to cloud ERP have been pointed out, such as difficulties in changing and conducting ongoing training for the processes [8], security [8,12,13], confidentiality [12], network reliability and integration problems [12], an increased risk of data loss [8], and ambiguity in the performance of cloud services and data processing [13].

On-premise ERP systems are hosted by organizations who handle their own infrastructure, operating systems and software, and database services and hardware [27]. However, such an approach makes it difficult to access information remotely [26], and the system data are not in real-time, which indicates an inadequate reliability [28]. In addition, the organization must install and operate all hardware and software, which requires intricate work [29]. However, cloud ERP systems have a variety of advantages, such as a fast construction, low initial cost, rapid upgrades and updates, the ability to handle changes and growth, and the ability to back up and restore data [30].

In general, on-premise ERP and cloud ERP have a commonality in that they both require tasks and tests for integration with other linked systems [8], but there are very clear differences in the construction methods and maintenance of fundamental

technology, TCO calculation, implementation / distribution / update / maintenance of solution applications with respect to task changes, scalability, security, performance, and technical support. Despite these differences, most cloud ERP providers use conventional on-premise ERP construction methods to carry out vendor-oriented cloud ERP construction projects. Vendor-specific construction processes, pricing policies, billing methods, solution flexibility, and support programs increase the difficulty for the customer who wants to select and implement the optimal cloud ERP solution through a strategic approach [14]. Therefore, the development of a standardized cloud ERP construction process framework from the customer's perspective is required for application to all cloud ERP selection methods, while increasing the reliability and scalability to overcome the limitations of on-premise ERP systems, such as system integration issues within an organization and the cost constraints [15, 16, 17].

In this study, a cloud-based ERP construction process framework from the customer's perspective is proposed by gathering and classifying the construction processes used by each commercial cloud ERP vendor, currently having a high market share. Furthermore, process engineering characteristics of the proposed model are examined through comparisons with those of the on-premise ERP. The results of this study can be used as basic data for the development of a standardized cloud ERP construction methodology to provide guidelines at a practical level for customer's perspective cloud ERP construction.

2. Related Work

2.1. Comparison Between Cloud-based ERP and Traditional On-Premise ERP

In reviewing previous studies related to ERP, the focus is on comparing traditional on-premise ERP and cloud ERP, which is a new method of implementing ERP. Table 1 shows the results. However, despite a variety of comparative studies on cost, usability, maintenance, scalability, implementation, security, mobility, and quality, studies on specific comparisons or methods of construction processes are lacking. Table 1 lists comparative studies conducted on cloud ERP and on-premise ERP. In the comparison results (which include the factors, criteria, and high and low grades), this paper cites the results of studies by various researchers without modification, or comparison factors found in the papers comparing cloud ERP and on-premise ERP, and the main content is presented in the comparison results.

2.2. Spiral Model of software development

The primary functions of a software process model are to determine the order of the stages involved in software development and evolution and to establish the transition criteria for progressing from one stage to the next [70]. A spiral model is one type of software development process model, and as its main feature, it adopts a risk-oriented

approach to the software processes. As shown in Fig. 1, the spiral model expands a system by repeatedly cycling through 4 phases. In Phase 1, the objectives, methods, and constraints are determined. In Phase 2, the risk factors are analyzed and resolved. In Phase 3, the software is developed and evaluated. Finally, in Phase 4, plans for the next phase are generated. The radial dimension shown in Fig. 1 represents the cumulative cost incurred in accomplishing the steps to date; in addition, the angular dimension represents the progress made in completing each cycle of the spiral [70]. The main advantages of this model are an improved software quality and the flexibility to respond to changes owing to the nonlinear and iterative nature of the development. However, when systems are developed incrementally, it can lead to high costs and failure if each cycle is not managed well or if a risk analysis is not properly conducted. As such, this model is suitable for projects in which problems with the technology and performance are anticipated.

Table 1. Comparison between cloud-based ERP and traditional on-premise ERP through preliminary studies

Factor	Criteria	Cloud ERP	On-Premise ERP
1. Cost	Upfront investment [12],[13],[14],[15],[16],[17],[18], [19],[20],[24],[36],[37],[38],[39], [40],[41],[42],[43],[44],[45]	Not High	High
	License [12], [13], [14], [17], [32],[36],[46],[47]	Low, handled by the provider, services in pay-per-use mode	High, user license required
	Energy [13]	Low	High
	Maintenance [12], [13], [14], [15], [16], [17], [21], [22], [32], [36], [44], [46], [48], [49], [50], [51], [52], [53]	Low	High
	Server [12], [14]	Low, availability	High
	Configuration [13]	Low	High
	Reduction in IT staff [14]	Low	High
2. Usability	Testability [13]	High	Low
	Upfront validation [13]	Easy	Difficult
3. Maintenance	Training [12]	required	Not required
	Upgrading and debugging [12], [15], [16], [37], [40], [42], [45], [48], [53],[54], [55]	Easy, upgrading can be done without affecting the services	Difficult
	Switching provider [12]	Easy	Not possible
	Target scope [12]	Focus shift to main competencies	Overall
	Data and environmental standards [12], [15], [21], [22]	Not ensured	Easy
	Availability & reliability [12], [14]	System and data recovery possible	System and disaster recovery are difficult.
	Controlling single point operation [14]	Easy	Difficult
	Enhancement [12], [22], [37], [40], [42],[45],[48],[53],[54],[55]	Moderately Easy	Difficult

	Compliance [12]	Moderately difficult	Easy
	Resource share and assignment [12], [14], [16], [38], [41], [42], [47], [50],[52],[56],[57],[58], [59] [60], [61],[62]	Easy, improves Agility	Very difficult
	Excellent dedicated staff [5],[32]	Required	Not required
4. Scalability	Extended services [12],[13],[14],[22],[36]	High	Low
	Integrated applications [12], [15],[16],[18],[21],[36]	Difficult	Possible
	Reports and analyses [12]	All the information can be grouped together easily and reports are generated in the required format	
	Data grouping	Moderately easy	Moderately difficult
5. Implementation	Time [13], [23], [36], [38], [41], [42], [43], [45], [47], [48], [49], [55], [62], [63], [64]	Very little	Long, 6 to 12 months or more
	Change [13],[36]	rapid	long
	Location [12]	Only client machines installed at the customer site	on the company premises
	Requirements [12]	Does not support complete back office requirements	High, rich functionality
	Customization [12],[15],[21],[22], [23],[37],[39],[40],[41],[48],[49],[51],[53],[54],[56],[64],[65],[66]	Provider based approach, integration difficult	Complete customization and integration supported
	Type [14]	SME company	Large enterprise
	Migration [12], [16]	Easy	Moderately complex
6. Security	Control privilege [13], [16], [20], [22], [23]	Low, owned by product owner	High
	Control safety [13],[16],[20],[21],[22],[23],[45], [47],[67],[68]	Low	High
	Attacks targeting shared tenancy environment [14]	High	Low
	Security and confidentiality [12],[36],[45],[49],[65]	Very difficult	Very high
	Web security [8]	High	Low
7. Mobility	System flexibility [12],[15],[16],[22]	High	Low
	Accessibility [12],[36],[41], [43],[56],[59],[67],[69]	Low	High
	Efficiency [1], [4]	Improved	Low
	Decision making process [12]	Improving, easier	Low
8. Quality	Network performance [12],[32]	Completely dependent on	Not dependent on
	Performance optimization [15], [21],[22]	Low	High
	Accuracy [12]	Improved	
	Data integrity [14],[47],[67],[68]	High	Moderately low

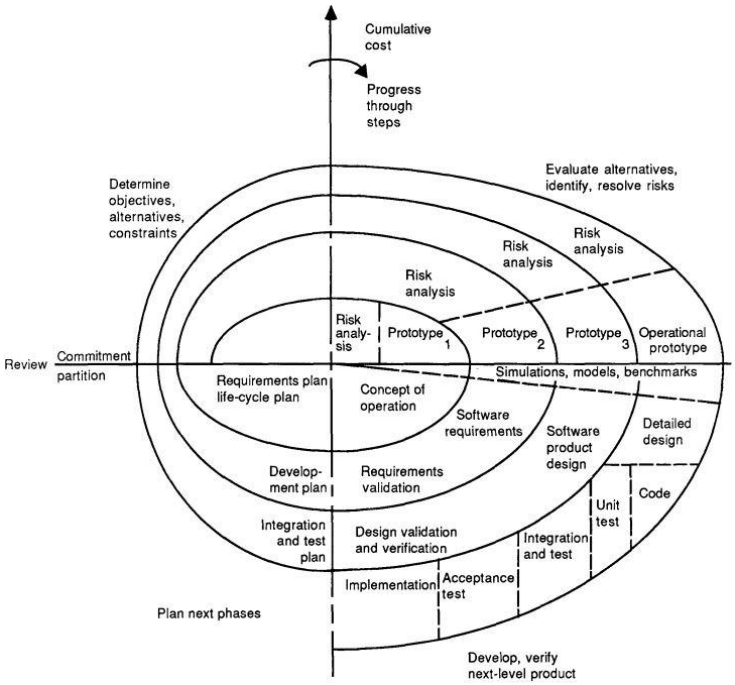

Fig. 1. Spiral model of the software process [70]

3. Research Procedures and Methods

3.1. Research Procedures

For this study, the construction processes used by each commercial cloud ERP vendor as well as the actual work breakdown structure (WBS) and schedule data used when constructing the cloud ERP systems were collected. Based on this, the processes, activities, and tasks for ERP construction were derived in three hierarchical levels through the KJ technique. Furthermore, the on-premise ERP construction process framework, derived as a result of preliminary research conducted separately, was combined with the study results of other researchers related to cloud ERP processes, to develop a customer-based process framework, which was further classified into IaaS, PaaS, CaaS, and SaaS according to the construction type of cloud ERP. To examine the differences, commonalities, and implications, the process engineering characteristics of the finally confirmed cloud-based ERP construction process framework from the perspective of the customer were analyzed and compared with those of the on-premise

ERP construction process framework. Fig. 2 shows the procedures and methods used in the study described above.

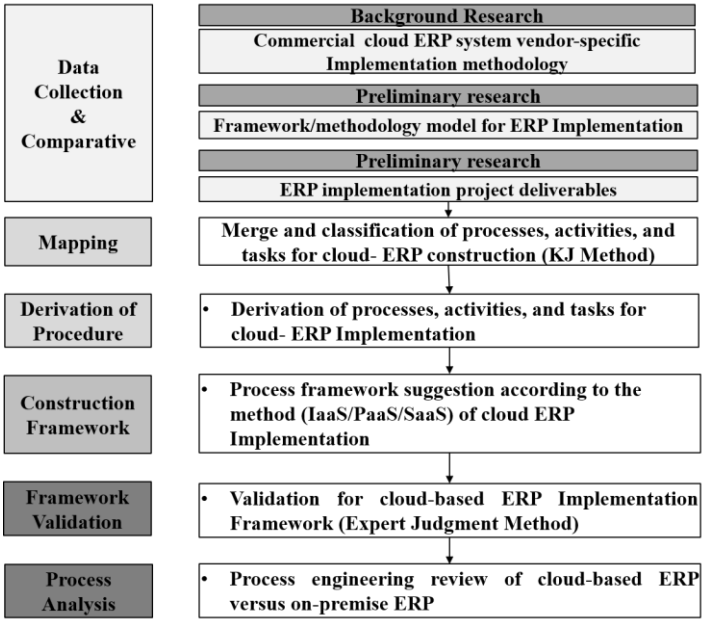

Fig. 2. Research process and Method

3.2. Research Method

KJ Method

The KJ technique, named after Kawakita Jiro, is used to classify and group various items based on their similarity or relevance [33]. In this study, the technique was used to group similar or identical process items and attach representative process names to the grouped results, based on the results of various studies on cloud ERP construction methodologies, processes, and frameworks, as well as vendor-specific methodologies, WBS, and schedules, which are practical types of data. Through this technique, fragmented information can be organized into groups with a high logical cohesion.

Expert Judgment

Expert judgment is defined as judgment provided based upon expertise in an application area, knowledge area, discipline, industry, etc., as appropriate for the activity being

performed, such expertise may be provided by any group or person with specialized education, knowledge, skill, experience, or training [34]. Expert judgement has always played a large role in science and engineering. Increasingly, expert judgement is recognized as just another type of scientific data, and methods are developed for treating it as such [35]. Such judgement was used as a method to validate the results of the cloud ERP construction process framework derived through this study, focusing on experts with ample experience in cloud ERP construction.

Each expert presented opinions on the IaaS, PaaS, CaaS, and SaaS ERP models, referring to a table of the processes, activities, and tasks for constructing the derived framework and the cloud ERP. The experts wrote their opinions in advisory documents, which included questions regarding each phase of the framework, such as, “Are the cloud ERP construction process (commercial vendor phase) and cloud ERP model division appropriate?” In addition, “Are all of the major activities for each process included?” Finally, “Are any major tasks omitted for each process activity?” This study sought validation opinions regarding the study results from experts working at YoungLimWon SoftLab and incorporated these opinions into the study. YoungLimWon SoftLab is a Korean ERP specialist company that launched its own ERP brand, called K-System, in 1997 and currently services over 25,000 customers in Korea and abroad [11]. The experts who provided the expert judgment for this study were the company’s executive vice presidents, who have over 20 years of actual experience in carrying out cloud-based ERP construction projects.

4. Suggestion of a Cloud-based ERP Construction Process Framework in the Customer’s Perspective

4.1. Data Collection

Considering the market share and utilization size, data and processes were collected for vendor-specific construction methods by selecting the commercial ERP software of eight companies: SAP S4HANA Cloud Process, Oracle Cloud, Microsoft Dynamics 365, Acumatica Cloud, Intuit, YoungLimWon SaaS Cloud, Infor Cloud, and Epicor. As shown in Table 2, processes are classified into a minimum of five phases up to a maximum of eight phases. Vendors are observed to follow very different processes. Furthermore, the number and scope of activities performed in each procedure for each process are very different. Detailed construction processes are provided with six phases and 86 tasks / activities for the SAP S4HANA Cloud ERP construction, whereas activities for each process are not clearly and explicitly defined for Microsoft Dynamics 365, Acumatica Cloud ERP, Intuit, and YoungLimWon Cloud ERP.

In examining the intrinsic characteristics of the processes, it was found that the review activities prior to construction were highly sub-divided in the case of Acumatica Cloud ERP, and the live phase was excluded from the processes in the case of Infor Cloud ERP. On the other hand, the processes of Epicor Cloud ERP consisted of prepare and plan, unlike SAP Cloud ERP. Considering the case of cloud-based ERP

construction projects that transform on-premise-based information services to cloud-based information services, the research results of Deok-Soo Oh et al. [24] were reviewed and reflected upon in addition to the activity and task items of each process.

Table 2. Processes and activities by Cloud ERP Vendor

Vendor	Cloud ERP S/W	Process	Activity
SAP	S4HANA Cloud ERP	1. Discover 2. Prepare 3. Explore 4. Realize 5. Deploy 6. Run	71 activities including Discovery Assessment
Oracle	Oracle Cloud ERP	1. Plan 2. Implement 3. Verify 4. Prepare 5. Deliver	21 activities including Project Definition
Microsoft	Dynamics 365 ERP	1. Preparation and planning 2. Procedure review 3. Data preparation 4. Testing and training 5. Rollout and evaluation	15 activities including Project Team Building
Acumatica	Acumatica Cloud ERP	1. Discovery 2. Plan & Monitor 3. Analyze 4. Build 5. Stabilize 6. Deploy 7. Post Go live	12 activities including Project Strategy Development
Intuit	Intuit ERP	1. Research and planning 2. Product-company fit 3. Budgeting 4. Data migration 5. Testing 6. Training 7. Go-live 8. Post-implementation considerations	11 activities including Requirement Review
YoungLimWon	SaaS Cloud ERP	1. Discover 2. Prepare 3. Provisioning 4. Consulting 5. Live	15 activities including Verification of Service Goods
Infor	Infor Cloud	1. Inception 2. Elaboration 3. Construction 4. Transition 5. Optimize	16 activities including SW Supply
Epicor	Epicor Cloud	1. Prepare 2. Plan 3. Design 4. Validate 5. Deploy	17 activities including Scope Definition

Traditional ERP construction consists of the following stages: pre-implementation, project planning, an as-is study, a to-be design, a gap analysis and customization, system configuration, conference room pilot, user training, user acceptance testing, installation and set-up, data migration, go-live, and post-implementation [25].

However, major ERP vendors devise and use their own methodologies for properly implementing their products. Typical examples include methodologies such as SAP's Accelerated SAP (ASAP), Oracle's Unified Method (OUM), and Microsoft Dynamics Sure Step. These methodologies are compared in Table 3, which was created by

reorganizing the studies in [13],[25],[31],[71]. In particular, OUM, which is a follow-up to the Application Implementation Methodology (AIM), reclassified 6 phases and 12 processes of AIM into 5 phases and 35 processes.

Table 3. Vendor specific methodology (ASAP, OUM, Sure Step)

SAP	Preparation	Business Blueprint	Realization	Final preparation	Go Live & Support
	•Initial Project Planning •Project Procedures • Training • Kick Off •Technical Requirements •Quality Check	•Project Management • Organizational Change Management • Training •Develop System Environment •Organizational Structure Definition •Business Process Analysis •Business Process Definition •Quality Check	•Project Management • Organizational Change Management • Training •Baseline Configuration & Confirmation •System Management •Final Configuration & Confirmation •Develop Programs, Interfaces etc. •Final Integration Test •Quality Check	•Project Management •Training •System Management •Detailed Project Planning • Cutover •Quality Check	•Migration to Production Environment •Production Support •Monitoring •Performance Optimization
OUM	Project Design	Configure	Validate	Transition	Realization
	•Plan Project •Conduct Kickoff Meeting •Schedule Workshops •Conduct Functional Design Workshops •Conduct Technical Design Workshops •Conduct Design Review •Develop Security and Validation Strategies and Plans •Conduct Implementation Checkpoint •Project Management	• Setup Applications •Validate Configuration •Load & Validate Data •Build & Validate Integrations •Apply & Validate Extensions and Extensible items •Implements Security •Prepare Cutover strategy •Conduct Implementation Checkpoint •Project Management	•Update Setups •Prepare Validation Scripts •Load & Validate Data •Conduct End-to-End Review •Prepare for Training •Conduct Train-the-Trainer Workshops •Conduct Implementation Checkpoint •Project Management	•Migrate Configuration Production •Migrate Integrations Extensions Production •Load, Reconcile & Validate Data in Production •Conduct Final Validation Review •Verify Production & Operational Readiness •Begin Production Use •Conduct Implementation Checkpoint •Project Management	•Manage toTransition to Steady state Operations &•Post Go-Live toSupport •Handoff to Customer Relationship Manager •Gain Acceptance •Close Project
Sure Step	Diagnostic	Analysis	Design	Development	Deployment	Operation
	•Cultivate Customer Relationship •Pre-Sales Support •Execute Decision Accelerators •Complete SOW	•Finalize Project Plan and Project Charter •Execute Functional Requirements Workshop •Execute Fit Gap Analysis •Develop Test Plan	•Conduct Core Team Training •Develop Functional Design Documents for Configurations (Fits) •Develop FDD's for Customizations (Gaps) •Demo CRP (For Rapid Project Type)	•Configure/Setup solution •Conduct Process Testing •Conduct Integration Testing •Manage Scope and Resolve Issues •Complete Solution Design Document	•Conduct Train the Trainer (TTT) Training •Conduct Use Training •Conduct User-Acceptance Testing •Perform Go-Live Readiness Activities •Ready Solution for Production Deployment	•System Go-Live •Post Production Support [Additional Phases] Optimization - Upgrade

4.2. Merging and Classification of Cloud-based ERP Construction Processes, Activities, and Tasks Using the KJ Technique

After combining all collected data, unique numbers were assigned to the cloud ERP methods, processes, and activities to derive standard processes independent of the vendor. The relevance index was evaluated by focusing on specific activities and tasks. In deriving processes, similar and same processes are classified as one group for each vendor in the primary KJ. In the secondary KJ, processes are grouped again by determining the uniqueness of each process when the task scope is broad or the agent performing the role is unclear. Based on this, a total of six processes were derived through mapping. In the tertiary KJ, tasks derived from a previous study [24] are added onto the processes for the construction of on-premise ERP.

The tasks were all reassigned to vendor-specific activities according to the derived processes. Unique numbers were used instead of activity or task names to efficiently derive tasks for each process. Because the finalized tasks were assigned based on this process, the characteristics, the scopes, domains, and agents of the tasks were very broad. Therefore, tasks were reclassified and grouped to clarify the scope and domain of each, and a suitable name was given to each group, thus deriving a major activity for each process.

4.3. Cloud-based ERP Construction Processes

A refining process was performed to finalize the results classified in the form of process, activity, and task in the final cloud ERP construction process. Through this procedure, the names of processes, activities, and task terms were modified to clarify the meaning. Furthermore, when it became necessary to classify the processes in terms of users and vendors, terms were redefined based on the role, even for the same activity name. The procedural tasks for deriving final construction results, such as understanding of customer's business and project communication, were deleted considering the diversity of the methods.

4.4. Development and validation of Cloud-based ERP Construction Process Framework in the Customer Perspective

The derived processes, activities, and tasks were classified into SaaS, CaaS, PaaS, and IaaS according to the type of cloud ERP construction. Typically, cloud ERP is purchased as SaaS, PaaS, or IaaS based on the construction type. However, four phases, including CaaS, were provided so that vendors and customers could all refer to them for solutions based on the application, and the roles and collaboration conditions could be clarified.

To practically validate the derived framework, review opinions were collected from two expert executives at YoungLimWon SoftLab, and who have many years of experience in constructing actual cloud-based ERP. The first expert has experienced the construction of IaaS- and SaaS-based ERP systems more than 20 times over the course

of a 5-year period. The other expert has over 7 years of experience in ERP construction and has applied SaaS ERP in more than 30 location. For validation, the experts reviewed the derived framework and all of its processes and answered 15 questions to confirm whether the construction procedure, model classifications, and the activities and tasks included in each process were appropriate or had any omissions. After confirming these issues, they provided their opinions. Table 4 provides an overview of the review opinions.

Table 4. Overview of expert opinions

Expert	Overview of expert judgements
Expert 1	- The derived cloud ERP construction process is thought to be suitable for medium-sized companies or larger customers whose business processes are standardized into an Organization Process Assert (OPA) format and whose company possesses adequate human resources. - The process will be difficult to apply to customers who are relatively small businesses and do not have clear process standards and who rely on best-practice processes. - A cloud-based ERP construction model selection activity/task must be added to the project planning and preparation of the customer process. - A configuration management activity/task must be added to the explore and rollout preparation process - A data migration verification activity/task must be added to the realization and data migration process - An integrated test and verification task must be added to the verification and training process activities.
Expert 2	- In relation to cloud ERP construction processes, from the end-user perspective, it would be a good idea to separate the construction used to introduce SaaS-based ERP from the cloud computing-based IaaS and PaaS. - It would also be a good idea to conduct additional research on the customization. - Activities/tasks related to the introduced customization of the customer must be supplemented in the explore and rollout preparation process. - There is a need for activities/tasks related to the provisioning (infrastructure, platform, and software) during the realization and data migration process. - There is a need for a usage analysis activity/task in the Post Go-Live process in the service management dimension.

The cloud-based ERP process framework was finalized to reflect the judgements of the experts. The cloud-based ERP process framework was suggested in the form of adding application content as a service (CaaS), as shown in Table 5, to clarify the scope of modularized unit services and the roles of the process framework between users and the vendor when constructing a cloud-based ERP system. This is to secure the flexibility of the framework that is useful to both users and vendors.

Based on preliminary studies [5], [13], [15], and [72], IaaS and PaaS were reconfigured by reflecting their phases and activities recently provided by vendors. CaaS and SaaS were classified based on Software Engineering Body of Knowledge (SWEBOK), a knowledge system of software engineering that is defined based on ISO/IEC 24773. SWEBOK is largely composed of SW engineering and SW management areas. In the derived activity, the element corresponding to SW engineering was placed as CaaS and that corresponding to SW management was placed as SaaS. Based on the same principle, the framework of commercial vendors such as SAP, Oracle, and MS is presented by dividing them into vendor, customer, and shared roles

based on the activity subject. Therefore, considering the SWEBOK theory and framework of commercial vendors, customers perform service preparation, testing, and data validation through the use of production functions, operations management, and support activities. In contrast, vendors perform activities related to function and technology for services, design, service and security implementation, data transfer and verification, and implementation verification and check. Considering this theoretical basis and the framework of commercial vendors, the service for customers was placed on the SaaS layer, and the vendor role was placed on the CaaS layer.

In addition, to minimize customer risk, which is the biggest advantage of this framework, an ERP SW technical review was placed in the Project Planning and Preparation of Customer Process of the PaaS and CaaS Layers to enable risk analysis by layer and process iteration cycle within one layer. This minimized the risk of cloud ERP deployment by allowing technology-focused analysis of all risks that can be derived from cloud ERP implementations, such as organizational, skills', project management, system, user, and technical risks [71].

Table 5. The process framework for cloud-based ERP construction

	Project Planning and Preparation of Customer	Explore and Rollout Preparation	Realization and Data Migration	Verification and Transition	Deployment and Distribution	Post Go-live
Software-as-a-service (end-user service)	Project governance, ERP project planning, ERP SW technical review, Preparation inner, Enterprise/ organization	ERP project kick-off	Application user training, Data migration, Quality control	Validation	Evaluation, System go-live, Inspection and completion (report)	Evaluation
Application Component-as-a-service	ERP SW technical review (Risk Analysis)	Analysis & design	Realization, Integration, Quality control	Test & verification, Transition, Training, Quality control	Deployment, System go-live	Addition and release of new service, Optimization
Platform-as-a-service	ERP SW technical review, License CAPEX [1], MSP[2] & CSP[3]	Middleware (development tools and processes), System SW (OS, DB, WAS, JDK), Runtime	Realization, Data, migration support, Quality control	Quality control	Biz. Analysis, Monitoring (security and regulation monitoring)	
Infrastructure-as-a-service	Infrastructure and solution, CAPEX, MSP & CSP	Virtual server, Virtual LAN configurations, Storage shares	Execution / Monitoring of project, Request and receive system, Quality control	Execution/ Monitoring of project, System go-live, Quality control	Management-as-a service, Execution/ Monitoring of project	Management-as-a service

1) CAPEX (Capital expenditures), 2) MSP (Managed Service Provider), 3) CSP (Cloud Service Provider)

Table 6 shows the cloud ERP construction processes finally derived through this procedure.

Expert 1 held the opinion that when cloud ERP is introduced, the customer size, data processing personnel, and links to existing legacy systems are extremely important factors in selecting the type of cloud computing-based ERP model. As such, the IaaS ERP construction model was recommended for customers requiring cloud ERP customization, PaaS for organizations with well-organized business development personnel, and SaaS for organizations with relatively small sizes whose systems are

being formed. In addition, because customization according to the customer requirements is practically unallowed for services in an SaaS format, Expert 1 was of the opinion that it is necessary to consider plans for how to flexibly respond if customers introducing SaaS want to develop their own processes as well as processes specialized for their specific industry.

Table 6. Processes, activities, and tasks for cloud-based ERP construction Framework

Process	Activity	Task
Project Planning and Preparation for Customer	Project Governance	Definition of strategy objectives, project initiation and governance, project vision and mission, high-level scoping, system requirement review
	ERP Project Planning	Collaboration between customer and vendor - Customer: application value and scoping, onboarding (on-the-job-training), customer team self-enablement, project initiation and governance, project plans, schedule and budget, project standards, infrastructure, and solution risk analysis. - Vendor: definition of project, project design, project planning, definition of project scope, strategy development, requirement review, cost review, system's initial module and goal setting, definition of requirements and project scope, review of installation plan, project blueprint
	ERP SW Technical Review	Cloud trial, ERP supporting implementation tool access, onboarding (on-the-job-training), initial system access for central business configuration, initial system access for cloud ERP S/W, ERP product review, product-company fit, checking service products, quote and simulation, interoperation scope review, provision and initialization of software, verification of software requirement satisfaction, quality control, commencement report meeting and quality control, choice of cloud-based ERP development model
	Preparation of Inner Enterprise/ Organization	Project team building, process automation review through new ERP functions and technology / process review, data research through examination and quotes of service products, setting the roles of internal organizations and teams, infrastructure, and solution
Explore and Rollout Preparation	ERP Project Kick-Off	Data migration approach and strategy, enable assessment, enable strategy, learning needs analysis for users, content development tool deployment (development tools and processes), system SW (OS, DB, WAS, JDK), runtime, quality check, phase closure and sign-off phase deliverables, system initial setting, user preparation, education, project kickoff meeting, phase closure and sign-off phase deliverables, customization requirement
	Analysis & Design	Analysis of specific business requirements, request system (product, quality), fit-to-standard analysis, customer execution of standard processes, fit-to-standard analysis documentation, integration planning and design, extension planning and design, analytics planning and design, identity and access management planning and design, new scope activation, new scope item activation for solution management, data load preparation, test planning, organizational change/configuration management impact analysis, determination of phase closure and sign-off, phase deliverables, quality management request, initial setup & system setting, quality check, data and workflow verification, service use request, major business data structure review, capturing and tracking specific items, phase closure and sign-off phase deliverables, virtual server, virtual LAN configurations, and storage shares
Realization and Data Migration	Realization	Production system request, request and receive system, alignment activities, quality system initial access, production system initial access, enable content development, required configuration before system use, solution configuration, new scope activation, new scope item activation for solution management, new country / region expansion for solution management, release cycles, setup instructions for customer driven integrations, integration setup in the quality / test landscape, analytics configuration in the quality system, identity and access management configuration, integration setup in the productive landscape, integration prerequisite, output management setup, solution extension development, solution walkthrough, test preparation & execution, enable delivery, support operations and handover plan, cutover preparation, analytics configuration in the production system, solution extension deployment on production, quality check, integration and interface verification, service execution, deployment preparation, provisioning (infrastructure, platform, and software), training plan establishment, environment setup, live input, organizational change/configuration management (OCM), phase

		closure and sign-off phase deliverables
	Data migration	Definition of migration data, refinement of migration data, collection of migration data, final data conversion, data migration execution based on usage and impact analysis, data verification, data conversion rehearsal, integration and interface data verification, phase closure and sign-off phase deliverables, project monitoring, request and receiving system, quality control
	Training	Key-user training, in-depth user training
Validation and Transition	Test & Verification	Data output test, confirmation of requirement satisfaction, functional test, process test, interoperability test, data validation, system test, system process validation, integration test
	Validation	Requirement satisfaction verification, deployment preparation in actual environment, client preparation, final user test, user approval test, solution walkthrough
	Transition	Final data conversion and migration, additional development and transition to changed module, production cutover, configuration in the production system, System Go-Live
	Training	ERP Training
	Quality Control	Continuous change management activities, quality, risk management, phase closure and sign-off phase deliverables, execution/monitoring
Deployment and Distribution	Deploy	New service deployment, execution/monitoring of project, production cutover
	Go-Live	Help desk operation, management-as-a service, biz. analysis, monitoring
	Evaluation	Periodic business closing and validation of settlement task
	Inspection and Completion Report	Final inspection and project completion, phase closure and sign-off phase deliverables
Post go-live	Addition and Release of New Service	Addition and release of new service, new scope activation, continuous improvement, revision and supplementation
	Optimization	Performance optimization, help desk operation, new user setup, fine-tuning, management-as-a service, usage analysis
	Evaluation	Operation status monitoring, evaluation of newly constructed service, evaluation of system operation/usability/quality

In regard to the desired direction of cloud-based ERP construction frameworks, Expert 2 was of the opinion that the ERP construction process for the provisioning and ERP environment settings should be provided as a self-service as soon as customers who introduce complete SaaS ERP are registered as members of the SaaS portal.

4.5. Model Analysis

A. Review of Process Framework for Cloud ERP Construction

Let us examine the characteristics of the process framework for the derived cloud ERP construction. First, the most salient characteristic is that each activity is presented according to the separation of the process derived in the framework into IaaS, PaaS, CaaS, and SaaS depending on the cloud ERP construction type. This can clarify the scope of the roles and responsibilities of the vendor and the company with respect to each software service type.

Next, let us examine the more detailed characteristics of each procedure in each process. The first process is the project planning and preparation of customer phase which consists of the following characteristics. First, detailed procedures and planning

activities must be performed by the customer in the stage of preparing for ERP construction, which can greatly help identify stakeholders and provide smooth communication. Second, project planning is common in both on-premise ERP construction and cloud ERP construction. However, while technical review remains at the requirement level when constructing on-premise ERP, the greater goal is to review the specific details of requirements in cloud-based ERP through the advance installation of ERP software. Third, the high-level requirement definition activity is derived as the most important procedure during the on-premise ERP construction process while the gap analysis of specific functions and non-functional requirements is facilitated in cloud ERP construction. Therefore, the effect of the ERP solutions is expected to be validated. Next, the standardization of regulations, assets, forms, etc. is derived as a very important task in the on-premise processes, whereas the integration with the company system and preparation of process automation are found to be very important prerequisites in cloud-based processes. Finally, the project team building is derived at the activity level in the case of on-premise ERP, but it is reduced to the task level in cloud-based ERP, demonstrating the benefits of reducing operations and management.

The characteristics of the second process, explore and rollout preparation, are as follows. During the on-premise ERP construction process, detailed plans have to be established when initiating the project and a kick-off report meeting should be held; furthermore, a lot of effort is put into constructing the project development environment. However, in the case of cloud-based ERP, general preparation tasks focus on enabling users to initialize the ERP service to derive requirements as quickly as possible, rather than focus on complex preparation for kick-off. Furthermore, compared to the on-premise process, the weight of as-is analysis and gap analysis are significantly less in cloud-based processes. This indicates that the boundary between the analysis and design is blurred in cloud-based ERP construction while the weight and importance of the tasks for the standard compliance and integration increase.

In particular, the detailed architectural design activity in the on-premise ERP construction process is dispersed among IaaS, PaaS, and CaaS in the cloud ERP construction process framework, significantly reducing and simplifying the workload. A lot of resources are injected into the prototype development, standard UI / UX design, business simulation, and master and sample data generation during the on-premise ERP construction process, whereas real-time work support is strengthened in the cloud-based development, which has evolved to operate in conjunction with artificial intelligence (AI) and decision-making services. In the past, when requirements were defined through a mock-up program, the requirement definition and analysis required a lot of time to prepare writing deliverables. In the cloud-based ERP, however, tasks can be performed in the form of planning-design, not planning-analysis-design, despite being complex ERP services.

The characteristics of the third process, the realization and data migration process framework, are as follows. Here, “Activation” has emerged as the primary theme among the tasks, meaning that the activity of selecting services in the nation or organization is performed frequently, based on already-existing modules, and it is determined that the ability to review the selected options is also required from customers. This is a good example demonstrating that one of the most prominent characteristics of cloud-based ERP is the change in “terminology.” Second, organizational change management (OCM) has emerged, which was not an important task in conventional development. In

other words, stakeholder management, communication management, organization management, human resources skill and competence management, and performance management are all important in ERP systems in terms of project management. In fact, according to a 2021 ERP report [8], change management according to organizational structure is one of the most difficult subjects to tackle in ERP operations. Third, by loading AI modules using ERP data, the system is expected to evolve in the direction of analysis and initialization based on the integration of the internal system with the services to be added to the basic tasks. Fourth, despite many issues in data migration, such as data loss and security issues, when constructing a cloud ERP system, the weight and complexity of tasks are significantly reduced compared to on-premise ERP construction. This is the result of vendors applying standardized data migration techniques and know-how as systems evolve in the direction of cloud ERP, rather than relying on the capability of persons in charge of migration for each project, as was the case in the past. Furthermore, although in cloud ERP, user environment preparation for major infrastructure services, initial-version creation of manuals, development of training materials, and operator training have been greatly reduced compared to on-premise ERP construction, a variety of user training tasks have to be performed frequently in the kick-off, realization, and deployment stages.

The characteristics of the fourth process, the validation and transition framework are as follows. The derived process shows that tests are very important in cloud ERP construction compared to on-premise ERP construction. Tests are treated as higher-level activities in cloud ERP. Tests are defined for independent processes during the cloud ERP software construction for every vendor except SAP with the goal of process validation. Second, in the case of transition, the process migration and transition are not needed if services are initiated using default modules in cloud ERP construction. Therefore, the big advantage is that service transition can be achieved by data migration based only on simple data conversion. However, in the case of customizing modules, limited transition tests, transition preparation, and transition may be selectively required. In particular, the transition process is free from the configuration tasks of the system's go-live environment, that is, checking whether the system operates normally, system monitoring, technical support, and checking the go-live operation compared to on-premise ERP. These benefits provided by IaaS are a major advantage. Furthermore, when the project is completed, tasks such as handover, planning related to work handover, stabilization support plan agreement, and support environment setup are greatly reduced or skipped.

In the fifth process, the deployment and distribution framework, the phase completion and inspection procedures are only performed as a matter of formality compared to on-premise ERP construction because of the characteristics of the transition process. In the framework of the post go-live process, the addition of new services is provided in the form of activity. Therefore, the characteristics are much more advantageous for flexible applications at the task level in cloud ERP construction although not optimized for specific corporate business logic compared to on-premise ERP construction.

B. Difference analysis with customer-based on-premise ERP process engineering

For the process analysis, the process engineering characteristics were examined based on the on-premise ERP construction process framework studied by Deok-Soo Oh et al. [24].

The customer-based on-premise ERP construction processes that were defined consist of seven phases: 1. Construction strategy planning, 2. Project kick-off, 3. Detailed analysis, 4. Detailed design and prototyping, 5. Development and testing, 6. Transition and project completion, and 7. Operation and improvement. On the other hand, the cloud ERP construction processes that were defined consist of six phases: 1. Project planning and preparation of customer, 2. Explore and rollout preparation, 3. Realization and data migration, 4. Verification and transition, 5. Deployment and distribution, and 6. Post go-live.

When differences in engineering are examined based on the above listed methods, it is found that first, the on-premise ERP construction processes adopted by most vendors are defined in a form resembling the waterfall model. However, in the case of cloud ERP construction processes, services can be provided on a story or feature basis, exhibiting characteristics very similar to that of the test-based development pursued by agile process models. Cloud ERP though, is different in that it provides a condition to activate already-existing solution applications for immediate distribution and review, instead of directly developing applications on a story or feature basis to meet the customer requirements for construction or expansion. This is in line with recent trends in technology that place importance on the customer's perspective on cooperation to more easily and quickly support business requirements, thus providing a driving force that enables customers to realize strong benefits in terms of judging the success and failure of ERP construction. Customers have a belief that the construction of cloud ERP is very successful and perceive that the return on investment (ROI) is, in fact, very strong [8].
Second, many activities required when constructing an ERP system are eliminated or reduced. In the case of on-premise ERP [24], all processes during project kick-off, detailed analysis, detailed design and prototyping, development and testing, operation and improvement, require tasks, such as change management, quality control, risk and issue management, and report management for integrated management of performance control activities. After construction, application service performance, service quality, and stabilization support are the most important tasks. However, in the case of cloud ERP, all these processes have been taken care of by the vendor, or automatically modified results are received in the form of services. In particular, when a SaaS-based ERP system is implemented, the enterprise-wide services are operated and maintained with minimal selections at the organization level. In software engineering, this is a very innovative change in terms of software management, which includes software configuration management, software engineering management, software engineering process, software engineering models and methods, and software quality, the so-called umbrella processes. For example, the information management department of an organization focuses on operations that can directly contribute to business management, such as technology standardization and planning, corporate data utilization and analysis, new technology applications (e.g., task integration and linkage with artificial intelligence solutions), rather than traditional operations, such as manual updating and upgrading, service quality control, performance management, user management, system monitoring,

and optimization. This provides opportunities for a variety of changes which can enhance the total economic impact (TEI) of the company.

Third, the risk analysis task adopted in the spiral process model is provided explicitly. The spiral model was proposed by Boehm and has the effect of reducing opportunity costs and increasing benefits of testing and feedback by evaluating the risk of failure during cloud ERP construction. When selecting cloud ERP, it is explicitly stated that risk analysis has to be performed in the strategy establishment phase. Thus, the proposed cloud ERP construction model provides an opportunity to focus on maximizing the company-wide use of ERP and the business effects, unlike the on-premise construction, in which many resources are focused on the successful construction of the ERP system. In recent years, even though the size of companies implementing cloud ERP has decreased, the big bang approach has increased by about 7 % [8]. This implies that the companies implementing cloud ERP have determined that the risks of adopting cloud-based ERP software provided by the vendor, changing and expanding technology, and integrating with existing systems are much easier to manage in terms of corporate operations compared to the past on-premise ERP construction.

Fourth, the strategic thinking about operation and maintenance has shifted: the company should be flexible about continuous change and evolution of enterprise-wide information services as work processes change. The major activities in the operation and improvement phase after the construction of on-premise ERP are bug fixes of solutions and engine uploads [24]. However, when the post go-live process of cloud ERP is examined in the derived framework, additional release of new service and activation of new service emerge as major tasks. This is in stark contrast to on-premise ERP, which is very sensitive to linkage failure and focuses only on stabilization in the operation and maintenance phase after construction of services, thus placing low priority on the requirements for new service addition, change, or expansion. In fact, a survey on the benefits of implementing cloud ERP showed that 96.6 % of organizations realize benefits in operational efficiency, 85.7 % in reporting and visibility, 80 % in updating technology, and 68.4 % in corporate growth and competition [8]. These results show that strategic thinking in implementing and operating cloud ERP is sufficiently reasonable.

C. Difference analysis based on commercial cloud ERP methodology

As the biggest difference between typical commercial cloud ERP methodologies and the process framework derived in this study, the derived framework is not limited to the SaaS level, i.e., simply introducing ERP software, but instead determines the systems and major development-related activities and tasks that must be carried out for the customer to introduce cloud-based ERP, and it defines these as IaaS and PaaS activities. By clearly defining the activities and tasks related to implementing the servers and development environment, which are omitted from conventional commercial software processes, the derived framework informs the customer of the many preparations that must actually be carried out when introducing cloud-based ERP. In addition, all procedures, activities, and tasks are defined such that they can be used universally in lieu of construction procedures that are defined by certain commercial ERP vendors, focusing on their own ERP software. As such, organizations that want to introduce a

cloud ERP can choose the construction methods through a tailoring of the process with the ERP vendor and collaboration between the organization introducing the ERP and the organization constructing it. This may help shift toward a collaborative ERP construction in which communication occurs with the customer rather than an ERP vendor-led construction. In this study, there is actually a need for customization after introducing SaaS ERP, which in this case should be clearly separated from the operating SaaS. By considering this point and separating SaaS and CaaS, it becomes easier to distinguish between reference activities and tasks when constructing each unit service.

In addition, Table 7 compares this study approach to the most widely used SaaS ERP construction methodologies provided by certain commercial vendors.

Table 7. Difference by commercial vendor-specific ERP methodology

	ASAP	OUM	Sure Step	Process Framework in present study
Stage classification terminology	Phase-activity	Phase-activity	Phase-activity	Process-Activity-task
Basis for classification	-	-	-	ISO/IEC 12207
1st Layer	**5- Phases system** 1. Preparation 2. Business Blueprint 3. Realization 4. Final preparation 5. Go Live and support	**5- Phases system** 1. Project Design 2. Configure 3. Validate 4. Transition 5. Realization	**6- Phases system** 1. Diagnostic 2. Analysis 3. Design 4. Development 5. Deployment 6. Operation	**6-processes system** 1. Customer project planning and preparation 2. Exploration and rollout preparation 3. Realization and data migration 4. Verification and transition 5. Deployment and distribution 6. Post go-live
2nd Layer	33 activities	35 activities	24 activities (optional +2)	21 activities
3rd Layer	Not defined	Not defined	Not defined	194 tasks
Usability	Vendor specific	Vendor specific	Vendor specific	All vendors and customers
Target of framework	Vendor oriented	Vendor oriented	Vendor oriented	Customer oriented
Coverage	SaaS based	SaaS oriented	SaaS oriented	All type oriented (SaaS, CaaS, PaaS, and IaaS)

5. Conclusion

In this study, a process framework was derived for cloud ERP construction, whereby each process of cloud ERP construction was examined in detail based on the derived results by comparing the process engineering characteristics to those of on-premise ERP construction. To this end, various activities from preliminary research results were collected and mapped to the construction processes of commercial cloud ERP vendors through the KJ technique, deriving as a result six processes, 21 activities, and a very broad range of tasks for each activity. The six processes consisted of project planning and preparation of customer, explore and rollout preparation, realization and data migration, validation and transition, deployment and distribution, and post go-live. There are four derived activities—project governance, ERP project planning, ERP software technical review, preparation inner enterprise / organization —for the project planning and preparation of customer process; two activities—ERP project kick-off and analysis & design—for the explore and rollout preparation process; three activities—realization, data migration, and training—for the realization and data migration process; five activities—test & verification, validation, transition, training, and quality control—for the validation and transition process; four activities—deployment, go-live, evaluation, and inspection & completion report—for the deployment and distribution process; three activities—additional release of new service, optimization, and evaluation—for the post go-live process. Specific unit tasks for construction were defined for each activity. Using the defined results, a framework was proposed by classifying IaaS, PaaS, CaaS, and SaaS according to the cloud ERP construction type for each of the six processes to suggest activities to be performed in each process. The process engineering characteristics were analyzed based on the finally derived framework, and the differences and similarities were examined through comparisons with the on-premise ERP construction.

This study provides a theoretical basis for cloud ERP construction method along with research and standardization. In addition, intrinsic activities and unit tasks are provided for each process of cloud ERP construction, distinct in practice from the on-premise ERP construction processes. The study can be used as a process tailoring tool to provide clear details of activities or tasks to all customers and vendors constructing cloud ERP systems. This will contribute to reliable cloud-based ERP construction in providing clear guidelines for smooth communication, specific preparations, and tasks to focus on for each stakeholder.

However, the cloud-based ERP construction framework in this study, which considers the customer perspective, covers the entire range of cloud computing in which ERP is constructed and used; however, an extremely limited validation was conducted during the validation phase by experts with ample experience under all cloud computing conditions, including IaaS, PaaS, and SaaS types. Therefore, a continued validation and revision must be applied based on additional reviews by experts and the use of actual examples. In future studies, it will be necessary to test these limitations, allowing the customer-oriented cloud-based ERP construction process framework, which considers the applicability, to evolve to the next stage.

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