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A Study of Factors Affecting Intention to Adopt a Cloud-Based Digital Signature Service

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Abstract: The electronic signature service has been causing various problems due to the rapid growth of e-commerce services. Therefore, in order to create an authentication service suitable for the era of the 4th Industrial Revolution, new security authentication technologies such as the cloud must be utilized. However, there is a lack of prior management studies on the intention to accept digital signatures. Therefore, this study conducted an empirical study to identify factors affecting the intention to adopt cloud-based digital signature services. This research proposed a model based on the technology–organization–environment framework and empirically analyzed the degree of mutual causality and influence between variables using the partial least squares structural equation model. The results show that technical characteristics, organizational characteristics, and environmental characteristics significantly affected the intention to adopt. However, there are still many concerns about the security of cloud-based services. It has been confirmed that solving this problem is the key to the activation of the electronic signature service.

Keywords: cloud-based service; digital signature; intention to adopt; security; technology–organization–environment framework

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1. Introduction

The authentication certificate service in Korea is a government-led electronic signature service that started on 1 July 1999. However, the service has several problems. First, a variety of security authentication technologies are being developed, but in Korea only one certificate is permitted by law, which makes it difficult for the service to be conducted in the private sector. Second, since all responsibilities arising from the authentication certificate service belong to the user, e-commerce operators and financial institutions have created a moral shortfall in that they will not take responsibility for authentication risks and damages. Third, the method of using the service is too strict and inconvenient, and many users suffer. Lastly, since an authentication certificate must be stored and carried on a physical storage medium (hard disk, USB, etc.), problems such as theft, loss, renewal, password leakage, and unusability arise when not being carried on such a medium.

As an alternative to these various problems, in 2017 the first cloud-based digital signature service using cloud technology and biometric authentication technology was launched in the United States and is currently spreading all over the world. However, most research on cloud-based digital signatures consists of engineering studies, and few have been carried out in the field of business administration.

Therefore, through empirical study this paper aims to investigate selected factors affecting the intention to adopt the next generation of digital signature services based on cloud and biometric authentication technologies. It further contributes to the generic acceptance model and its key factors on cloud computing adoption by exploiting the Technology Acceptance Model (TAM) and the Technology–Organization–Environment (TOE) application into a specific cloud security service area—that is, cloud-based digital

signatures. The results of this study are expected to enhance the understanding and cognitive evaluation of companies and individual customers in the cloud digital signature field, which has witnessed relatively little research activity in the field of business administration. Additionally, since the legally mandated certified digital signature service in Korea has been gradually easing since March 2018, we believe that research on the next-generation authentication service—the cloud-based digital signature service—is very timely.

2. Literature Review

2.1. Cloud Computing Service

Cloud computing refers to a computing method in which users use leased servers, storage, and software, etc., as necessary and pay service providers only for what they use, even if they do not have specialized knowledge or skills [1]. This cloud service attracted attention as a new survival strategy for enterprises as the world faced an economic crisis in 2009, and related research has been conducted in the field of business administration [2].

Low et al. [3] used the TOE framework to conduct a study of the key factors affecting the acceptance of cloud computing. The results of the study confirmed that the technical characteristics, organizational characteristics, and environmental characteristics had a positive effect on acceptance. Mohammed et al. [4], as in previous studies, used the TOE framework, the work skill fit theory, and skill readiness variables. The main implication of their results is that uncertainty can be a major variable, and it was suggested that an integrated model can be built using the TOE theory, technology readiness, and work skill suitability in research on the acceptance of cloud computing services.

Park and Kim [5] conducted research using the TAM and suggested that the perceived mobility, usability, connectivity, security, and service and system quality are the main variables affecting the intention to accept mobile cloud services. Pańkowska et al. [6] also used the TAM model to study the factors influencing users' adoption of sustainable cloud computing solutions and suggested that perceived availability and security affect the perceived usability and system service quality, and both variables affect attitudes and usage.

Oliveira et al. [7] used the theory of diffusion of innovation and the TOE model to confirm that technology readiness and top management support have a positive effect on acceptance, while complexity has a negative effect.

Gangwar et al. [8] conducted a study by integrating the TAM and TOE models. As a result, it was confirmed that relative advantage, fitness, organizational competence, education and training, and top management support positively affect perceived ease and usefulness, while competitor pressure and partner support positively influence acceptance intention.

2.2. Cloud Digital Signature Service

Cloud-based digital signature is a technology and service that stores authentication keys in the cloud to eliminate theft, leakage, renewal, and the inconvenience of portability and performs and guarantees the qualification and authentication of one's transaction activities through biometric authentication technology [9]. These services have been expanding all over the world, starting in the United States in 2017; however, the corresponding research in business administration is still insufficient.

Quinting et al. [10] constructed a theoretical model for the adoption of a sustainable cloud digital signature service based on the TOE model and the theory of diffusion of innovation. Based on the TAM, Kim et al. [9] conducted an empirical study on factors affecting the intention to accept cloud digital signature services.

2.3. Technology–Organization–Environment Framework

The technology–organization–environment framework is a model that allows for the understanding of the adoption of technology and information systems in an organizational context rather than by an individual [11]. In addition, the TOE model is integrated with

the theory of diffusion of innovation to explain the organization's acceptance of technology and information systems [7,11,12].

2.4. UTAUT Model

The technology acceptance model has been actively used by scholars in many fields to study the introduction of new technologies, information systems, and services. However, the number of variables to be applied is limited and the explanatory power of the model is low; hence, there is a limit to the validity of the research [13]. Therefore, among scholars, the unified theory of the acceptance and use of technology (UTAUT) was proposed to overcome the limitations of TAM [14].

Venkatesh et al. [13] use performance expectation, effort expectation, social impact, and promotion conditions as the independent variables of the UTAUT model and gender, age, and spontaneity of experience as the control variables.

2.5. Task−Technology Fit Model

The task−technology fit (TFF) model represents how well information technology supports an individual when performing a task [15,16]. In addition, in the TTF model fit is closely related to personal satisfaction [17]. In the field of business administration, many researchers are deriving research results with a focus on the task−technology fit of individuals.

Raven et al. [18] applied the TTF model to digital video presentation and performance among students. The variables affecting the model were divided into general work characteristics and technical characteristics, and the fit was classified into suitability of work, ease of use, and ease of learning. As a result of the study, it was found that both job characteristics and technical characteristics had a positive effect on task−technology fit and fit had a positive effect on usefulness and student performance.

Kim et al. [19] conducted a study applying the TTF model to the study of the effect of big data analysis technology on expected performance. As a result of the study, the task−technology fit was found to have a moderating effect on intention to use and personal performance.

2.6. Service Readiness

The degree of readiness has been academically defined as the degree of technical readiness of the worker for the acceptance of technology, and corresponding research has been conducted [20]. Technology readiness is defined as the tendency of people to adopt new skills to achieve their goals in their home life and at work [20]. However, recently research on readiness has been applied to the service field beyond the scope of technology.

Kim [21] conducted a study on the customer satisfaction model of new services. The result of the study revealed that readiness had a positive effect on the perceived usefulness, ease, and enjoyment of new services.

3. Research Model and Hypothesis Testing

3.1. Research Model

In this study, a structural research model was designed by adding the economic characteristics that were not utilized in the previous studies to the technology–organization–environment theory to reveal the factors influencing the intention to accept the cloud-based digital signature service. The study model is shown in Figure 1.

3.2. Hypothesis Development

3.2.1. Technical Characteristics and Suitability

Mohammed et al. [4] revealed that technological characteristics such as relative advantages, compatibility, complexity, trialability, and security affect the cloud computing adoption. In TOE theory, technical and business characteristics affect technical suitability [16]. When practitioners' ability to perform work is improved through new technologies,

the fitness of the practitioners' skills will increase, and organizations will try to introduce new technologies accordingly [16]. Therefore, this study established the following hypotheses based on prior studies regarding technical characteristics and suitability.

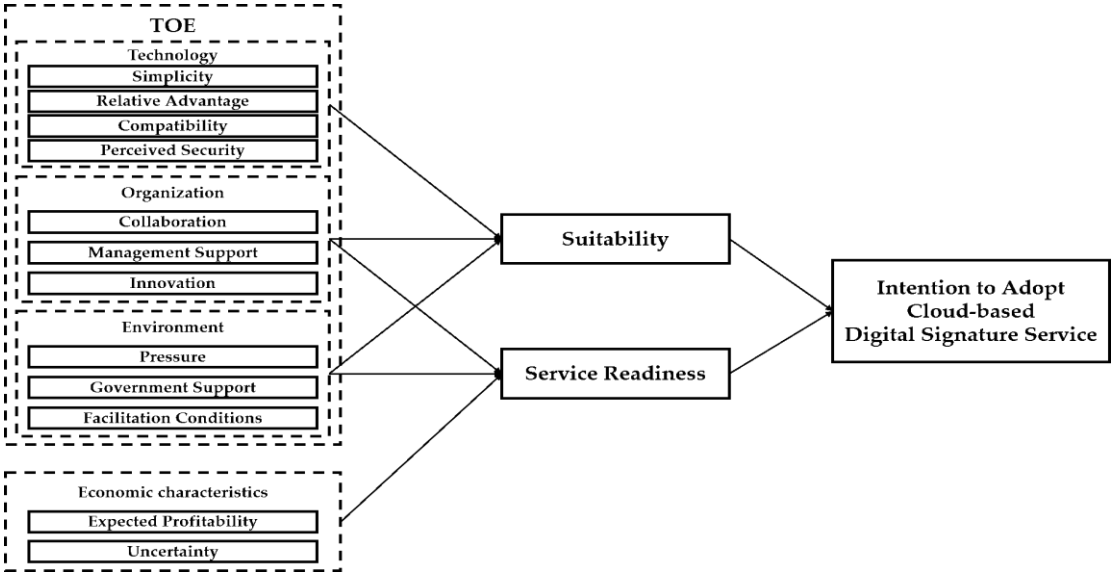

Figure 1. Research model.

Hypothesis 1 (H1). *Simplicity has a positive effect on suitability.*

Hypothesis 2 (H2). *Relative advantage has a positive effect on suitability.*

Hypothesis 3 (H3). *Compatibility has a positive effect on suitability.*

Hypothesis 4 (H4). *Perceived security has a positive effect on suitability.*

3.2.2. Organizational Characteristics and Suitability

In TOE theory, organizational characteristics are mainly divided into collaboration, management support, and organizational innovation [22]. The characteristics of work, such as collaboration within an organization and sufficient support therein, can significantly impact fitness and technical characteristics [15,18]. Therefore, this study established the following hypotheses based on previous studies on organizational characteristics and suitability.

Hypothesis 5 (H5). *Collaboration has a positive effect on suitability.*

Hypothesis 6 (H6). *Management support has a positive effect on suitability.*

Hypothesis 7 (H7). *Innovation has a positive effect on suitability.*

3.2.3. Organizational Characteristics and Service Readiness

If the users of a new technology have a positive emotion, it is easy to accept the technology, but if they have a negative emotion they resist the technology [23]. Users' emotions are influenced by the organization's situation, and if the organization is more innovative and well supported the individual will have positive emotions [23]. Therefore, this study established the following hypotheses based on previous studies of organizational characteristics and service readiness.

Hypothesis 8 (H8). *Collaboration has a positive effect on service readiness.*

Hypothesis 9 (H9). *Management support has a positive effect on service readiness.*

Hypothesis 10 (H10). *Innovation has a positive effect on service readiness.*

3.2.4. Environmental Characteristics and Suitability

In technology–organization–environment theory, environmental characteristics such as government support and competitor pressure have a direct impact on the organization's acceptance of technology and services [24]. Facilitation conditions in introducing new technologies or services also affect the internal environmental characteristics felt by practitioners [13]. Therefore, this study established the following hypotheses based on previous studies on environmental characteristics and suitability.

Hypothesis 11 (H11). *Pressure has a positive effect on suitability.*

Hypothesis 12 (H12). *Government support has a positive effect on suitability.*

Hypothesis 13 (H13). *Facilitation condition has a positive effect on suitability.*

3.2.5. Environmental Characteristics and Service Readiness

Positive emotions have a significant effect on service readiness and acceptance [23]. Government support and facilitation conditions were found to elicit positive emotions [23]. Therefore, this study established the following hypotheses based on prior studies of environmental characteristics and service readiness.

Hypothesis 14 (H14). *Pressure has a positive effect on service readiness.*

Hypothesis 15 (H15). *Government support has a positive effect on service readiness.*

Hypothesis 16 (H16). *Facilitation condition has a positive effect on service readiness.*

3.2.6. Economic Characteristics and Service Readiness

This study's expected profitability can be seen as an organization's financial preparation for the introduction of new services. In research on the introduction and innovation of information systems, financial investment and financial readiness are considered important factors for organizations to adopt and develop technology [25]. Uncertainty acts as an impediment to the organization's ability to prepare services, because it makes the results unpredictable [26]. Uncertainty will serve as a factor that hinders service readiness when an organization introduces a new service because it makes it impossible to accurately predict outcomes. Therefore, this study established the following hypotheses regarding economic characteristics and service readiness based on previous studies.

Hypothesis 17 (H17). *Expected profitability has a positive effect on service readiness.*

Hypothesis 18 (H18). *Uncertainty has a positive effect on service readiness.*

3.2.7. Suitability and Intention to Adopt

The suitability of work skills can be said to be a concept that acts as an influencing factor for organizations or individuals to introduce new technologies as a result. Organizations tend to adopt technology and services naturally when work is highly suitable [18,19,27,28]. Therefore, this study established the following hypothesis based on previous studies on suitability and intention to adopt.

Hypothesis 19 (H19). *Suitability has a positive effect on intention to adopt.*

3.2.8. Service Readiness and Intention to Adopt

Technology readiness refers to the tendency of consumers to use new technologies to achieve their goals [23]. In addition, technical readiness can be said to be an open mind that embraces even obstacles [29]. In other words, the higher the service readiness, the more likely that an organization or individual will adopt new services and technologies. Therefore, this study established the following hypotheses regarding service readiness and intention to adopt based on prior studies.

Hypothesis 20 (H20). *Service readiness has a positive effect on intention to adopt.*

3.3. Variable Operational Definition and Questionnaire

Table 1 shows the operational definition of the study variables included in the hypothesis and model of this study.

Table 1. Operational definitions of variables and their questionnaire item.

Variable	Operational Definition and Questionnaire	Related Studies
Simplicity (SM)	Degree of ease and simplicity of cloud-based digital signature service • It is easy to use. • It requires less mental effort to use. • It takes less time to learn how to use.	[30]
Relative advantage (RA)	Degree of perception that cloud-based digital signatures are better than traditional digital signatures • It makes our electronic signature work easier. • It saves time when performing related tasks. • It increases the productivity of my work. • It increases the efficiency of my work. • It can be useful in my work.	[4,7,30]
Compatibility (COM)	Degree of compatibility between cloud-based digital signature service and company infrastructure • It can be used as the company's existing IT infrastructure. • It can also work with other business systems in our company. • It takes only a small amount of technological change to use this. • It fits well with the way we do business. • It can replace the existing method used by our company.	[4,31]
Perceived security (PS)	Degree of belief that the process of using the cloud-based digital signature service is safely protected • Its data security level is high. • Its privacy level is high. • It is safer than the existing digital signature. • It blocks unapproved abnormal connections well.	[4,7,31]
Collaboration (COL)	Degree of collaboration between departments, such as exchange activities and mutual support to achieve common goals within the organization • Our company works hard to achieve common goals, such as cross-departmental collaboration. • Our company conducts various exchange activities between departments. • Our company mutually supports the necessary human resources and resources between departments. • Our company responds jointly to market changes between departments. • Our company strives to improve relationships between departments when problems arise.	[22,32,33]
Management support (MS)	Degree of management support for information system introduction and cloud-based digital signature introduction and use • Our company's top management is interested in introducing information systems. • Our company's top management supports the introduction of cloud-based digital signature services. • Our company's top management recommends using a cloud-based digital signature service. • Our company's top management is proactive about introducing cloud-based digital signature services.	[22,34]
Innovation (INO)	Degree of organization's willingness to actively pursue and leverage innovation • Our company's top management actively pursues innovative ideas. • Our company accepts innovation well. • Our company gives us a penalty if the proposed idea does not work. • Our company is reluctant to accept innovation and does not accept it well.	[22,35]

Table 1. *Cont.*

Variable	Operational Definition and Questionnaire	Related Studies
Pressure (PRES)	Degree of competitor influence in introducing cloud-based digital signature services • I think cloud-based digital signature services are affecting the company's competitiveness. • I think our company is being pressured by the competition to introduce cloud-based digital signature services. • I know that some of our competitors are already using cloud-based digital signature services. • I think there are disadvantages if our company does not use cloud-based digital signature service. • I think social factors are important factors in introducing cloud-based digital signature services.	[7,24,30]
Government support (GS)	Degree of governmental financial and legal assistance to support the adoption of cloud-based digital signature services • It is recommended by the government. • It allows for legal protection. • It is safe because all laws and regulations are in place.	[7,24]
Facilitation conditions (FC)	Degree of support associated with the organization's infrastructure to introduce cloud-based digital signature services. • Our company is increasing its knowledge base to use cloud-based digital signature services. • Our company provides professional technical support for using cloud-based digital signature services. • Our company provides sufficient training to use cloud-based digital signature services. • Our company is receiving various marketing incentives from cloud-based electronic signature service providers.	[13,36]
Expected profitability (EP)	Degree of investment, maintenance, and other costs involved in the introduction of cloud-based electronic signature services • The introduction of cloud-based digital signature service can reduce investment in new infrastructure. • The introduction of cloud-based digital signature service can reduce system maintenance cost. • The introduction of cloud-based digital signature service can bring many benefits.	[4,25]
Uncertainty (UNC)	Degree of unpredictability due to the introduction of cloud-based digital signature service • I think that the cloud-based e-signature service is not working well, and can disrupt company business. • I think the availability of servers for cloud-based e-signature services is poor, which can lead to disruptions in the company's business. • I think the new cost model of cloud-based digital signature service is not clear, so it is impossible to know the cost−benefit ratio.	[7,26]
Suitability (SUIT)	Degree of suitability of cloud-based digital signature services and tasks that organization members feel to do their jobs • I think it has all the features that a cloud-based digital signature service need. • I think the cloud-based digital signature service has the proper functions to perform my job. • I think a cloud-based digital signature service is good enough to get the job done. • I think the cloud-based digital signature service meets my business needs. • I am satisfied with the quality of the cloud-based digital signature service. • I am satisfied with the functionality of the cloud-based digital signature service.	[7,37]
Service readiness (SR)	Degree of company preparation for the introduction of cloud-based electronic signatures perceptual to the members of the organization, such as budget, policy, and technical resources • Our company provides an adequate budget for the introduction of the system. • Our company provides an adequate budget for the maintenance of the system. • Our company has implemented appropriate policies related to data management and security. • Our company has the technical manpower necessary to introduce cloud-based digital signature service. • Our company provides employees with regular updates on the knowledge related to cloud-based digital signatures.	[8]
Intention to adopt a cloud-based digital signature service (IA)	Degree of thought or plan to introduce cloud-based digital signature service • Our company has already introduced and used cloud-based digital signature service. • Our company has been discussing the introduction of cloud-based digital signature service but has not taken any concrete measures. • Our company discussed the introduction of a cloud-based digital signature service but decided not to adopt it at this time. • Our company has planned to introduce a cloud-based digital signature service.	[31]

4. Research Method and Results

4.1. Sample Design and Data Collection

In order to understand the factors affecting the intention to adopt a cloud-based digital signature service, this study collected data from participants through a seven-point Likert

scale questionnaire based on prior research. The survey in this study was conducted by a professional survey company, the Korea Office of Entrust Survey, Seoul, South Korea, for around four weeks from 1 August to 31 August 2019. Data were collected through questionnaires distributed to 300 participants online. We requested data to be collected from companies in various industries. For research purposes, the total samples collected should include 200 from companies that use cloud services and 100 from companies that do not. Finally, after excluding 17 unusable responses, 283 samples were used for the analysis. There is no clear standard for sample size in the structural equation model, but the minimum number of samples for path analysis is 200 or more [38,39]. Therefore, this paper was considered to satisfy the criteria in using the structural equation model. For empirical analysis, a frequency analysis and normality test were conducted through the SPSS 23.0 statistical program, and a factor analysis as well as validity and reliability analysis were performed using the 'plspm' package provided by R programming. In addition, hypothesis testing was performed using partial least squares structural equation modeling (PLS-SEM). The demographic characteristics of the sample for empirical analysis are shown in Table 2.

Table 2. Demographic characteristics of the sample.

Construct		Frequency	Percentage (%)
Gender	Male	134	47.3
	Female	149	52.7
Age	20−29	49	17.3
	30−39	137	48.4
	40−49	73	25.8
	50−59	15	5.3
	60+	9	3.2
Industry field	Financial	7	2.5
	Public	50	17.7
	IT	41	14.5
	Manufacturing	74	26.1
	Distribution	24	8.5
	Service	55	19.4
	Machinery	5	1.8
	Electronics	6	2.1
	Etc.	21	7.4
Position	Staff	188	66.4
	Team leader	68	24.0
	Department head	22	7.8
	Executives	5	1.8
Corporation size (staff)	2 or more and less than 100	112	39.6
	100 or more and less than 500	89	31.4
	500 or more and less than 1000	41	14.5
	More than 1000	41	14.5
Cloud use or not	Use	187	66.1
	Not	96	33.9
Total		283	100

4.2. Factor Analysis

Before evaluating the external model, an exploratory factor analysis was conducted through outer factor loading to confirm whether the questionnaire items in this study fit the purpose and intention of the study and to test the research model. The evaluation criterion should be that the factor loading of each indicator exceeds 0.6–0.7 and is higher than that of other indicators [40]. The results are as shown in Table 3.

Table 3. Results of factor loading.

	SIM	RA	COM	PS	COL	MS	INO	PRES	GS	FC	EP	UNC	SUIT	SR	IA
SIM1	0.911	0.691	0.583	0.447	0.461	0.432	0.445	0.333	0.320	0.390	0.517	0.115	0.544	0.345	0.320
SIM2	0.833	0.531	0.409	0.334	0.371	0.217	0.170	0.165	0.254	0.212	0.298	0.050	0.364	0.178	0.173
SIM3	0.879	0.588	0.511	0.425	0.382	0.303	0.341	0.194	0.255	0.289	0.392	0.053	0.388	0.248	0.200
RA1	0.684	0.829	0.605	0.459	0.411	0.439	0.400	0.350	0.271	0.367	0.491	0.089	0.495	0.337	0.340
RA3	0.577	0.863	0.629	0.393	0.388	0.477	0.384	0.385	0.293	0.398	0.445	0.046	0.527	0.373	0.392
RA4	0.615	0.905	0.652	0.447	0.450	0.472	0.402	0.407	0.299	0.441	0.475	0.110	0.573	0.413	0.392
RA5	0.564	0.867	0.653	0.397	0.468	0.461	0.329	0.394	0.322	0.418	0.426	0.040	0.562	0.385	0.400
COM1	0.452	0.575	0.755	0.335	0.354	0.328	0.290	0.221	0.157	0.271	0.402	0.177	0.403	0.309	0.225
COM2	0.454	0.569	0.804	0.368	0.417	0.427	0.330	0.317	0.262	0.348	0.398	0.138	0.431	0.349	0.316
COM4	0.492	0.635	0.864	0.410	0.464	0.592	0.491	0.451	0.419	0.534	0.512	0.136	0.553	0.548	0.518
COM5	0.520	0.623	0.850	0.472	0.377	0.453	0.375	0.378	0.327	0.429	0.455	0.064	0.523	0.391	0.392
PS1	0.429	0.457	0.433	0.915	0.369	0.417	0.393	0.298	0.463	0.323	0.402	0.013	0.399	0.368	0.319
PS2	0.450	0.443	0.440	0.928	0.385	0.429	0.403	0.287	0.456	0.377	0.380	−0.031	0.411	0.391	0.307
PS3	0.401	0.439	0.434	0.879	0.408	0.452	0.392	0.310	0.443	0.407	0.409	0.005	0.399	0.407	0.321
PS4	0.407	0.427	0.455	0.895	0.381	0.402	0.343	0.271	0.483	0.361	0.421	0.090	0.421	0.349	0.309
COL1	0.476	0.506	0.477	0.390	0.835	0.472	0.537	0.287	0.252	0.376	0.358	0.050	0.463	0.424	0.269
COL2	0.434	0.498	0.459	0.374	0.874	0.499	0.566	0.321	0.324	0.404	0.382	0.041	0.520	0.492	0.311
COL3	0.399	0.454	0.473	0.354	0.896	0.548	0.539	0.381	0.372	0.469	0.401	0.126	0.512	0.533	0.356
COL4	0.385	0.367	0.410	0.352	0.868	0.525	0.595	0.356	0.400	0.472	0.413	0.088	0.479	0.539	0.396
COL5	0.351	0.341	0.336	0.387	0.866	0.527	0.572	0.355	0.367	0.453	0.369	0.035	0.501	0.513	0.389
MS1	0.415	0.515	0.516	0.420	0.600	0.810	0.698	0.549	0.390	0.581	0.544	0.142	0.546	0.615	0.484
MS2	0.321	0.482	0.516	0.400	0.537	0.931	0.659	0.642	0.536	0.709	0.533	0.108	0.560	0.760	0.714
MS3	0.315	0.447	0.499	0.448	0.496	0.933	0.618	0.678	0.562	0.727	0.500	0.132	0.559	0.743	0.734
MS4	0.337	0.491	0.510	0.434	0.523	0.935	0.646	0.705	0.580	0.749	0.571	0.114	0.578	0.746	0.741
INO1	0.387	0.415	0.412	0.398	0.606	0.670	0.938	0.472	0.448	0.592	0.477	0.053	0.523	0.612	0.481
INO2	0.345	0.407	0.464	0.401	0.614	0.692	0.947	0.534	0.474	0.623	0.557	0.041	0.547	0.679	0.530
PRES1	0.279	0.454	0.402	0.247	0.405	0.613	0.487	0.768	0.540	0.659	0.542	0.066	0.631	0.524	0.536
PRES2	0.189	0.245	0.251	0.204	0.243	0.514	0.368	0.794	0.558	0.607	0.409	0.082	0.403	0.514	0.539
PRES3	0.188	0.386	0.387	0.275	0.318	0.639	0.446	0.818	0.541	0.598	0.478	0.065	0.434	0.606	0.667
PRES4	0.146	0.216	0.224	0.200	0.150	0.417	0.270	0.774	0.545	0.496	0.413	0.082	0.377	0.361	0.414
PRES5	0.264	0.379	0.374	0.321	0.362	0.561	0.468	0.761	0.582	0.538	0.497	0.080	0.479	0.499	0.477
GS1	0.250	0.286	0.327	0.366	0.332	0.542	0.471	0.700	0.870	0.670	0.477	0.021	0.542	0.527	0.610
GS2	0.339	0.337	0.347	0.497	0.370	0.486	0.450	0.606	0.896	0.606	0.533	0.003	0.579	0.506	0.482
GS3	0.262	0.286	0.313	0.488	0.354	0.500	0.379	0.569	0.887	0.587	0.471	0.000	0.545	0.541	0.497
FC1	0.287	0.428	0.447	0.327	0.443	0.755	0.604	0.728	0.618	0.893	0.541	0.046	0.622	0.751	0.724
FC2	0.274	0.412	0.453	0.344	0.445	0.731	0.583	0.702	0.650	0.917	0.536	0.063	0.671	0.756	0.685
FC3	0.323	0.403	0.434	0.328	0.475	0.633	0.570	0.600	0.565	0.886	0.442	0.000	0.655	0.700	0.587
FC4	0.364	0.397	0.404	0.432	0.382	0.538	0.481	0.569	0.615	0.780	0.528	0.013	0.614	0.540	0.486
EP1	0.359	0.347	0.420	0.320	0.268	0.443	0.417	0.490	0.435	0.454	0.814	0.133	0.423	0.486	0.390
EP2	0.428	0.499	0.516	0.433	0.424	0.544	0.500	0.551	0.527	0.553	0.884	0.120	0.593	0.547	0.473
EP3	0.416	0.480	0.432	0.364	0.421	0.504	0.467	0.482	0.439	0.464	0.820	0.128	0.565	0.486	0.414
UNC1	0.100	0.109	0.164	0.047	0.075	0.151	0.050	0.112	0.043	0.051	0.164	0.965	0.101	0.130	0.026
UNC2	0.060	0.027	0.113	−0.023	0.075	0.094	0.042	0.052	−0.046	0.009	0.107	0.910	0.027	0.083	−0.003
SUIT1	0.369	0.467	0.465	0.400	0.488	0.549	0.525	0.527	0.600	0.640	0.534	0.033	0.830	0.556	0.472
SUIT2	0.485	0.601	0.574	0.410	0.541	0.574	0.533	0.588	0.532	0.684	0.576	0.087	0.892	0.536	0.476
SUIT3	0.460	0.569	0.536	0.365	0.527	0.524	0.502	0.518	0.554	0.637	0.562	0.048	0.905	0.516	0.435
SUIT4	0.439	0.547	0.519	0.375	0.516	0.553	0.501	0.562	0.579	0.650	0.534	0.070	0.912	0.546	0.485
SUIT5	0.447	0.562	0.527	0.414	0.500	0.572	0.492	0.546	0.521	0.669	0.569	0.067	0.893	0.556	0.480
SUIT6	0.486	0.535	0.488	0.413	0.429	0.492	0.436	0.454	0.526	0.588	0.542	0.097	0.835	0.486	0.426
SR1	0.233	0.406	0.450	0.348	0.518	0.738	0.632	0.627	0.530	0.727	0.559	0.083	0.554	0.918	0.696
SR2	0.215	0.362	0.429	0.335	0.504	0.710	0.607	0.616	0.508	0.713	0.555	0.094	0.533	0.904	0.639
SR3	0.332	0.420	0.475	0.425	0.572	0.679	0.636	0.497	0.495	0.665	0.551	0.125	0.568	0.872	0.574
SR4	0.313	0.366	0.436	0.406	0.529	0.700	0.637	0.557	0.525	0.727	0.512	0.115	0.515	0.902	0.676
SR5	0.292	0.406	0.466	0.370	0.478	0.744	0.573	0.628	0.603	0.736	0.539	0.114	0.558	0.899	0.772
IA1	0.226	0.382	0.375	0.288	0.303	0.662	0.438	0.631	0.521	0.604	0.435	0.058	0.391	0.678	0.812
IA4	0.230	0.389	0.413	0.303	0.375	0.687	0.514	0.625	0.534	0.669	0.450	0.010	0.486	0.682	0.924
IA5	0.266	0.386	0.386	0.329	0.368	0.671	0.481	0.600	0.552	0.649	0.452	−0.012	0.492	0.658	0.936
IA6	0.279	0.431	0.455	0.332	0.389	0.670	0.503	0.609	0.551	0.668	0.496	0.004	0.527	0.683	0.933

4.3. Reliability and Validity Analysis

4.3.1. Reliability Analysis

The PLS structural equation first analyzes the reliability and validity of each variable through an external model analysis [41]. When the results of the external model analysis satisfy the presented criteria, a structural model analysis, which is an internal model analysis, is performed to grasp the relationship between the variables [41]. The internal consistency reliability is evaluated using the Cronbach's α value, DG's rho value, and the eigenvalue [40]. As shown in Table 4, the Cronbach's α value in this study meets the recommended criterion of 0.7 or higher [40,42]. In addition, the DG's rho value, which is a criterion for evaluating internal reliability in the reflection indicator model, satisfies

the cutoff of 0.7 or more, and the eigenvalue is also 1 or more, indicating that this study is suitable [40].

Table 4. Reliability analysis.

	MVs	Cronbach's α	DG's Rho	Eigenvalue
SIM	3	0.850	0.909	2.309
RA	4	0.889	0.923	3.002
COM	4	0.838	0.892	2.696
PS	4	0.926	0.947	3.274
COL	5	0.918	0.939	3.767
MS	4	0.924	0.947	3.267
INO	2	0.874	0.941	1.777
PRES	5	0.844	0.889	3.081
GS	3	0.861	0.915	2.347
FC	4	0.892	0.926	3.031
EP	3	0.790	0.878	2.116
UNC	2	0.870	0.939	1.770
SUIT	6	0.940	0.953	4.629
SR	5	0.941	0.955	4.042
IA	4	0.923	0.946	3.258

4.3.2. Validity Analysis

A validity analysis consists of convergent validity and discriminant validity [41]. In a PLS analysis, the convergent validity is evaluated by the average variance extracted (AVE) value [43]. As shown in Table 5, the AVE values of this study were all higher than 0.5, and it was determined that convergent validity was secured [41]. On the other hand, in the case of discriminant validity it can be said that the criterion is satisfied when the value of the square root of the AVE values of latent variables is greater than or equal to the correlation value of the latent variable and other latent variables [43,44]. In this study, it was judged that the discriminant validity was also secured because the value of the square root of the AVE value of each latent variable met the criteria.

Table 5. Discriminant validity analysis.

	SIM	RA	COM	PS	COL	MS	INO	PRES	GS	FC	EP	UNC	SUIT	SR	IA	AVE
SIM	0.875															0.765
RA	0.702	0.866														0.750
COM	0.585	0.733	0.819													0.671
PS	0.467	0.488	0.487	0.905												0.818
COL	0.469	0.496	0.495	0.427	0.868											0.753
MS	0.381	0.533	0.565	0.47	0.593	0.904										0.817
INO	0.388	0.436	0.467	0.424	0.647	0.722	0.942									0.888
PRES	0.278	0.442	0.431	0.323	0.392	0.714	0.533	0.783								0.613
GS	0.321	0.343	0.374	0.509	0.398	0.576	0.49	0.706	0.884							0.782
FC	0.354	0.47	0.501	0.405	0.502	0.769	0.645	0.749	0.702	0.87						0.758
EP	0.478	0.528	0.545	0.445	0.443	0.592	0.55	0.604	0.558	0.586	0.84					0.705
UNC	0.373	0.461	0.484	0.377	0.48	0.555	0.503	0.518	0.559	0.606	0.546	0.938				0.880
SUIT	0.502	0.635	0.611	0.458	0.599	0.682	0.613	0.649	0.639	0.781	0.658	0.745	0.878			0.771
SR	0.319	0.446	0.505	0.422	0.554	0.805	0.669	0.673	0.611	0.796	0.599	0.535	0.684	0.899		0.808
IA	0.282	0.432	0.461	0.347	0.397	0.716	0.526	0.652	0.578	0.802	0.502	0.449	0.593	0.739	0.902	0.814

4.4. Statistical Hypothesis Testing

The PLS structural equation uses a nonparametric test method that applies the bootstrapping method to ensure statistically significant path coefficients are obtained through

a path analysis [41]. In this study, the statistical significance of the path coefficient was secured through 1000 bootstrapping resampling and a hypothesis test was performed based on the t-value of 1.96 at the 5% level of statistical significance [41].

As shown in Table 6, of the 20 hypotheses 13 were adopted and 7 were rejected. First, the result of the hypothesis on the relationship between technical characteristics and suitability is presented. Hypothesis 1, which states that simplicity affects suitability, was adopted at a significance level of 0.019 with a path coefficient of 0.208 and a t-value of 2.352. Hypothesis 2, which states that the relative advantage affects suitability, was adopted at a significance level of 0.000 with a path coefficient of 0.247 and a t-value of 4.090. Hypothesis 3, which states that compatibility affects suitability, was adopted at a significance level of 0.050 with a path coefficient of 0.188 and a t-value of 1.962. Hypothesis 4, which states that perceived security affects suitability, was rejected at a significance level of 0.791 with a path coefficient of −0.033 and a t-value of −0.736.

Table 6. Result of path analysis.

Hypothesis	Path	Estimate	Std. Error	t-Value	*p*-Value	Result
H1	SIM -> SUIT	0.208	0.046	2.352	0.019	Accept
H2	RA -> SUIT	0.247	0.060	4.090	0.000	Accept
H3	COM -> SUIT	0.188	0.054	1.962	0.050	Accept
H4	PS -> SUIT	−0.033	0.045	−0.736	0.791	Reject
H5	COL -> SUIT	0.156	0.048	3.210	0.001	Accept
H6	MS -> SUIT	0.123	0.067	1.980	0.048	Accept
H7	INO -> SUIT	0.027	0.054	0.508	0.612	Reject
H8	COL -> SR	0.190	0.042	2.100	0.036	Accept
H9	MS -> SR	0.316	0.060	5.210	0.000	Accept
H10	INO -> SR	0.094	0.051	1.84	0.066	Reject
H11	PRES -> SUIT	0.009	0.061	0.154	0.878	Reject
H12	GS -> SUIT	0.209	0.057	3.640	0.000	Accept
H13	FC -> SUIT	0.417	0.064	6.440	0.000	Accept
H14	PRES -> SR	−0.061	0.055	−1.090	0.277	Reject
H15	GS -> SR	0.035	0.048	0.734	0.464	Reject
H16	FC -> SR	0.407	0.059	6.810	0.000	Accept
H17	EP -> SR	0.192	0.043	2.100	0.036	Accept
H18	UNC -> SR	−0.046	0.032	−1.440	0.150	Reject
H19	SUIT -> IA	0.125	0.049	2.510	0.012	Accept
H20	SR -> IA	0.666	0.049	13.400	0.000	Accept

Second, the result of the hypothesis on the relationship between organizational characteristics and suitability is presented. Hypothesis 5, which states that collaboration affects suitability, was adopted at a significance level of 0.001 with a path coefficient of 0.156 and a t-value of 3.210. Hypothesis 6, which states that management support affects suitability, was adopted at a significance level of 0.048 with a path coefficient of 0.123 and a t-value of 1.980. Hypothesis 7, which states that innovation affects suitability, was rejected at a significance level of 0.612, with a path coefficient of 0.027 and a t-value of 0.508.

Third, the result of the hypothesis on the relationship between organizational characteristics and service readiness is presented. Hypothesis 8, which states that collaboration affects service readiness, was adopted at a significance level of 0.036 with a path coefficient of 0.190 and a t-value of 2.100. Hypothesis 9, which states that management support affects service readiness, was adopted at a significance level of 0.000, with a path coefficient of 0.316 and a t-value of 5.210. Hypothesis 10, which states that innovation affects service readiness, is rejected at a significance level of 0.066, with a path coefficient of 0.094 and a t-value of 1.84.

Fourth, the result of the hypothesis on the relationship between environmental characteristics and suitability is presented. Hypothesis 11, which states that pressure affects suitability, was rejected at a significance level of 0.878, with a path coefficient of 0.009 and a t-value of 0.154. Hypothesis 12, which states that government support affects suitability, was adopted at a significance level of 0.000, with a path coefficient of 0.209 and a t-value of 3.640. Hypothesis 13, which states that the facilitation condition affects suitability, was adopted at a significance level of 0.000 with a path coefficient of 0.417 and a t-value of 6.440.

Fifth, the result of the hypothesis on the relationship between environmental characteristics and service readiness is presented. Hypothesis 14, which states that pressure affects service readiness, was rejected at a significance level of 0.277 with a path coefficient of −0.061 and a t-value of −1.090. Hypothesis 15, which states that government support affects service readiness, was rejected at a significance level of 0.464, with a path coefficient of 0.035 and a t-value of 0.734. Hypothesis 16, which states that the facilitation condition affects the readiness, was adopted at a significance level of 0.000 with a path coefficient of 0.407 and a t-value of 6.810.

Sixth, the result of the hypothesis about the relationship between economic characteristics and service readiness is presented. Hypothesis 17, which states that expected profitability affects service readiness, was adopted at a significance level of 0.036 with a path coefficient of 0.192 and a t-value of 2.100. Hypothesis 18, which states that uncertainty affects service readiness, was rejected at a significance level of 0.150 with a path coefficient of −0.046 and a t-value of −1.440.

Finally, the result of the hypothesis on the relationship between suitability, service readiness, and intention to adopt is presented. Hypothesis 19, which states that suitability affects intention to adopt, was adopted at a significance level of 0.012 with a path coefficient of 0.125 and a t-value of 2.510. Hypothesis 20, which states that service readiness affects intention to adopt, was adopted at a significance level of 0.000 with a path coefficient of 0.666 and a t-value of 13.400.

5. Discussion and Conclusions

This study attempted to identify factors that could affect the acceptance of cloud-based electronic signature services. To this end, based on the TOE theory used in prior research a research model was proposed by combining work technology suitability and service readiness, and the main results of the empirical analysis are as follows.

First, simplicity, relative advantage, and compatibility in the technical characteristics significantly impacted the suitability, but the perceived security did not significantly affect the suitability. Since this can be seen as a result of a lack of trust by consumers in the complementarity of cloud services, it is necessary to improve consumers' perception that the cloud service is safe, and this will take some time. In addition, simplicity, relative advantages, and compatibility lower resistance to the adoption of new technologies. Therefore, the cloud-based digital signature service should provide clarity and easy to use than the existing digital signature service and should eliminate difficulties in use and feel convenient by increasing compatibility with the company's infrastructure. This applies not only to cloud services but also to existing ICT-related services.

Second, it was found that collaboration and support from management in organizational characteristics had a significant effect on both suitability and service readiness, but innovation did not significantly affect either of them. This is consistent with the findings of Gil [22], in that collaboration and support from management have a significant effect on suitability. In addition, the innovation does not significantly affect suitability and service readiness. This result supports the results of Parasuraman [23] and Maduku et al. [34], in that organizations show resistance to innovation in the early stage, and such resistance acts as an impediment to innovation acceptance. Therefore, in order to introduce a cloud-based digital signature service, the interest and willingness of the decision-makers in an organization are indispensable, and the support of the management layer can be achieved only if the interest and willingness are the basis. Through this, it was found that departmental collaboration can be achieved. In order for this to work smoothly, the cloud-based digital signature being provided must be tailored to the organization compared to the existing service.

Third, in the relationship between environmental characteristics and suitability, both facilitation conditions and government support were found to have a significant effect. Through this, it is judged that the government's support is recognized as appropriate and causes the intention to adopt the investment to rise. In order to expand the govern-

ment's willingness to support the policy, companies must first actively seek support for this service and propose improvements to related laws and systems. However, only the facilitation condition was found to have a significant effect in relation to service readiness. It implied that the degree of influence of government support varies depending on the size of the company.

Lastly, it was found that the expected profitability in economic characteristics had a significant effect on service readiness. This supports the findings of Iacovou et al. [25]. In other words, it was concluded that the use of the cloud digital signature service raises the expectation that better profits can be generated than when using the existing service, and this could affect service preparation and intention to use. On the other hand, it was found that uncertainty did not significantly affect service readiness. This is in line with the existing research results of Das and Teng [26]. It was concluded that if the organization does not support the cloud-based digital signature service's reliability, this will lower expectations for service preparation.

However, this study has the following limitations. First, users' perceptions of cloud-based digital signature services have not been established. Since the current cloud-based digital signature service has just been introduced, there may be a difference in people's perception of it in the future.

Second, research from an individual perspective is also necessary. The survey used in the study sought to review the organizational perspective on accepting related services. As related services expand to the individual domain, future research needs to develop and analyze individual-level variables.

Lastly, there are limitations on variables for explaining all cloud-based digital signature services. In future research, it is expected that more interesting research results can be obtained by developing additional factors that can better describe cloud services, apart from variables originating from existing ICT research.

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