COMBINATION OF CMMI-DEV AND CMMI-SVC TO MEASURE IMPLEMENTATION MATURITY OF E-GOVERNMENT: A SYSTEMATIC LITERATURE REVIEW

KOMBINASI MODEL CMMI-DEV DAN CMMI-SVC UNTUK MENGUKUR TINGKAT KEMATANGAN IMPLEMENTASI E-GOVERNMENT: TINJAUAN LITERATUR SISTEMATIS

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Abstrak

Gagasan utama implementasi e-government adalah memberikan pelayanan yang optimal kepada warga melalui penerapan TIK. Untuk mengukur kematangan implementasi e-government dapat digunakan model pengukuran CMMI. CMMI dipilih karena memiliki model pengukuran sesuai dengan implementasi e-government, yaitu CMMI-DEV, yang berorientasi pada proses pembangunan, dan CMMI-SVC, yang berorientasi pada layanan. Selain itu, model pengukuran CMMI dapat dinilai sesuai dengan tingkat kematangannya. Tulisan ini bertujuan untuk meninjau secara sistematis proses spesifik pada CMMI-DEV dan CMMI-SVC yang dapat digunakan untuk mengukur kematangan implementasi e-government. Dalam tulisan ini digunakan metode tinjauan literatur sistematis dengan framework PRISMA, melalui pencarian artikel sebagai bukti bahwa proses spesifik CMMI-DEV dan CMMI-SVC dapat diukur dalam implementasi e-government. Proses review merekomendasikan agar semua proses spesifik dalam CMMI-DEV digunakan untuk ukuran kematangan implementasi e-government, namun hanya beberapa proses spesifik di CMMI-SVC yang direkomendasikan untuk dijadikan ukuran kematangan tersebut.

Kata Kunci: Kematangan, E-Government, CMMI-DEV, CMMI-SVC, PRISMA

Abstract

The main idea of e-government implementation is to provide an optimal service to the citizen through the application of ICT. To measure the maturity of e-government implementation, it can be used CMMI measurement model. CMMI is chosen because it has a measurement model in accordance with the implementation of e-government, namely CMMI-DEV which oriented to development process, and CMMI-SVC which is service-oriented. In addition, CMMI measurement model can be assessed in accordance with its maturity level. This paper aims to systematically review specific processes on CMMI-DEV and CMMI-SVC which can be used to measure the maturity of e-government implementation. A systematic literature review method with PRISMA frameworks is used as a method of composing this paper, by searching for articles as evidence that the specific processes of CMMI-DEV and CMMI-SVC can be measured in e-government implementation. The review process recommends that all specific processes in CMMI-DEV are measured to show maturity in e-government implementation, but only a few specific processes in CMMI-SVC are recommended to serve as a measurement of that purpose.

Keywords: Maturity, E-Government, CMMI-DEV, CMMI-SVC, PRISMA

INTRODUCTION

The initiative of e-government comes from a combination from improved public services and awareness of Information and Communication Technology (ICT) (Valdés et al., 2011). To meet public services, e-Government products are modeled and developed by best practices (Fath-Allah, Cheikhi, Al-Qutaish, & Idri, 2016), one of step in measuring and gaining maturity for electronic public services can be implemented by e-government maturity model.

Some maturity models are technology and infrastructure minded such as UN, The Waseda University, Gartner Group, World Bank, CMMI, COBIT, PeGI, and Warta Ekonomi (Napitupulu & Sensuse, 2015). Although e-government applications tend to be technology-oriented, it should be considered that users of e-government services are citizen. Therefore, the maturity measurement is not only based on technological, but also service delivery aspect.

The CMMI® maturity measurement model (Capability Maturity Model® Integration) is a popular model used by many organizations to improve information systems development (IS) processes. Improving the IS development process will be reflected in IS performance and its productivity, quality, customer satisfaction, and Return of Investment (ROI) (Alshaikh, Alsaleh, Alarifi, & Zarour, 2016).

The CMMI model consists of five levels of maturity (maturity 1 to 5, the higher the better the maturity). From its various application areas, CMMI has four variations, there are CMMI for Development (CMMI- DEV) (Team, 2010a), CMMI for Service (CMMI-SVC) (Team, 2010b), CMMI for Acquisition (CMMI-ACQ) (CMMI Product Team, 2010), and People CMM (Curtis, Hefley, & Miller, 2009).

Based on existing studies, this paper aims to systematically review the specific processes of CMMI-DEV and CMMI-SVC to measure the maturity of e-government implementation.

Theoretical Background

A. Maturity Models

E-government maturity implies that e-government initiatives reached a level of full development. Instead, e-government development seen as a continuing process that evolves in line with technology developments and innovation (United Nations, 2003). United Nations introduced E-Government Development Index (EGDI) a model to measure e-government maturity. Another example is PeGI which is used for e-government implementation in Indonesia which its components include Policy, Organization, Infrastructure, Application, and Planning (Napitupulu & Sensuse, 2015).

Another method called CMMI, CMMI is a collection of best practices for organizations to improve their processes. The models in CMMI are developed by a team of products composed of experts in industry, government, and Software Engineering Institute (SEI).

CMMI has defined two types of levels an organization must perform to improve its processes, these two levels are called Capability and Maturity levels. Capability levels apply to an organization's process improvement achievement in individual process areas. Capability level consists of four levels:

0) Incomplete: An incomplete process is a process that either is not performed or is partially performed.

1) Performed: A performed process is a process that accomplishes the needed work to produce work products; the specific goals of the process area are satisfied.

2) Managed: A managed process is a performed process that is planned and executed in accordance with policy; employs skilled people having adequate resources to produce controlled outputs; involves relevant stakeholders; is monitored, controlled, and reviewed; and is evaluated for adherence to its process description.

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3) Defined: A defined process is a managed process that is tailored from the organization's set of standard processes according to the organization's tailoring guidelines; has a maintained process description; and contributes process related experiences to the organizational process assets.

A maturity level is a defined evolutionary plateau for organizational process improvement. Each maturity level matures an important subset of the organization's processes, preparing it to move to the next maturity level. The maturity levels are measured by the achievement of the specific and generic goals associated with each predefined set of process areas. The level of maturity consists of five levels:

1) Initial: Processes are usually ad hoc and chaotic. The organization usually does not provide a stable environment to support processes.

2) Managed: The projects have ensured processes are planned and executed with policy; the projects employ skilled people who have adequate resources to produce controlled outputs; involve relevant stakeholders; monitored, controlled, and reviewed; and evaluated for adherence to their process descriptions.

3) Defined: Processes are well characterized and understood, described in standards, procedures, tools, and methods.

4) Quantitatively Managed: The organization and projects establish quantitative objectives for quality and process performance and use them as criteria to maintain projects.

5) Optimizing: An organization continually improves its processes based on a quantitative understanding of its business objectives and performance needs.

The existing levels in CMMI are used for organizations to maintain operational standards with CMMI target levels. Therefore, the higher levels in CMMI are achievements from previous levels. CMMI provides an associated process area with its maturity level, therefore the author proposed CMMI as model to measure maturity of e-government.

CMMI-DEV provides integrated guidance to develop a product and service that fits to requirement of customers and users. CMMI-DEV contains 22 process areas, 16 are core process areas, 1 is a shared process area, and 5 are development specific process areas. The entire process focuses on developer activity within the organization. Five processes focused on specific practices of product development i.e Requirements Development, Technical Solutions, Product Integration, Verification, and Validation (Team, 2010a). The whole process is associated at level 3 maturity level.

CMMI-SVC contains 24 process areas, 16 are core process areas, 1 is a shared process area, and 7 are service-specific process areas that include 1 additional process. The entire process in CMMI-SVC focuses on service provider activities. The seven specific processes i.e Capacity And Availability Management (Level 3), Service Continuity (Level 3), Service Delivery (Level 2), Incident Resolution And Prevention (Level 3), Service Transition (Level 3) Service System Development (Level 3), and Strategic Service Management Processes (Level 3) (Team, 2010b).

Both models (CMMI-DEV and CMMI-SVC) used as a foundation to search evidence of e-government implementation, and which specific area(s) are more suitable for matuity measurement.

B. PRISMA

The method used in this research is Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA). PRISMA is an evidence-based minimum set of items for reporting in systematic reviews and meta-analyses. PRISMA not only focuses on the reporting of reviews evaluating various research, but also reporting systematic reviews for other research, particularly evaluations of interventions (Moher, Liberati, Tetzlaff, &

Altman, 2009). PRISMA had chosen to ensure the study was transparent and replicable (Scheerder, van Deursen, & van Dijk, 2017)

C. Research Question

Based on existing studies and guidance from PRISMA, the authors would like to give a recommendation which specific process of CMMI-DEV and CMMI-SVC that can be used to measure maturity of e-government implementation.

D. Inclusion and Exclusion Criteria

The criteria in searching for articles, or journals, or research is English-written journals with the keywords "CMMI-DEV", "CMMI-SVC", "e-government", and research related to public services with each specific process CMMI-DEV and CMMI-SVC. Articles taken only from IEEE, Elsevier, and ACM. Articles containing keywords that have been mentioned but not listed in the three journals are not included. The selected articles are articles published in 2007 to 2017.

The articles selection done by searching articles on the IEEE Xplore Digital Library, ACM Digital Library, and ScienceDirect.com through the Universitas Indonesia library portal. The search was conducted in October. Boolean logic operators are also applied in a combination of keywords.

E. Article Selection Process

The search process with various keyword combinations provides a large list of articles. For the first step of article selection based on title and short description of the article.

F. Data Extraction and Synthesis

Data extraction helped by Microsoft Excel™ application. The relevant information from each selected articles saved in an Excel file. Excel file helps the conclusion and mapping of articles correspondence with each CMMI-DEV and CMMI-SVC specific process.

The data extracted in this process i.e research background, research theory, research variables, and research results. The synthesis in this review aims to identify and group the main ideas recorded in Excel files and to draw conclusions from similar ideas.

RESULT AND DISCUSSION

A. Article Selection Result

The search results of the three repositories can be seen in the Table 1.

Tabel 1. Search results from three repositories

Repository	Total Result	Appropriate with Search Criteria
IEEE Xplore Digital Library	42.430	27
ACM Digital Library	1.561	26
ScienceDirect.com	9.935	34
Total	53.926	77

B. Study Characteristics Result

Selected articles refined by e-government topics and contain a discussion of any specific CMMI-DEV and / or CMMI-SVC processes. The screening process produces 29 articles matched to review topics. Table 2 and Table 3 show the grouping of articles in CMMI-DEV and CMMI-SVC respectively.

C. Result of Individual Studies

The result of individual studies shown in Appendix.

D. Synthesis of Results CMMI-DEV

Based on articles review, each CMMI-DEV process area had implemented in e-government application. The result of its review presented below:

1. Requirement Development

The purpose of Requirements Development (RD) is to elicit, analyze, and establish customer, product, and product

component requirements. (Team, 2010a). Requirements assessed by (Alshaikh, Alsaleh, Alarifi, & Zarour, 2015) proved that RD is used to improve e-government development processes such as architectural and design needs. Requirements analysis of e-government products implemented by reviewing the technological challenges, existing design approaches, as well as the literature on e-government products so that the end product is effective and operates smoothly (Isagah & Wimmer, 2017).

Requirement Development will be much needed when e-government services are in the process of transition (Rao, Remer, & Bauer, 2014) and affected by legacy systems (Alexandrova, 2012).

2. Technical Solution

The purpose of Technical Solution (TS) is to select, design, and implement solutions to requirements. Solutions, designs, and implementations encompass products, product components, and product related lifecycle processes either singly or in combination as appropriate (Team, 2010a). Technical Solution is implemented in the implementation of e-government to facilitate interoperability of government data so that information sharing between government agencies runs smoothly in the hope of improving public services and informed decision making to support public policy making (Hou, Lampe, Bulinski, & Prescott, 2017).

Alternative Technical Solutions (Alshaikh et al., 2016) from mainstream solutions are an important point in e-government development, such as solutions that can be applied to bridge multi-organizational processes and applications according to Estevez (Estevez & Janowski, 2007) are Government-Enterprise Ecosystem Gateway (G-EEG). G-EEG aims to minimize the challenges in the implementation of seamless e-government.

3. Product Integration

The purpose of Product Integration (PI) is to assemble the product from the product components, ensure that the product, as integrated, behaves properly (i.e., possesses the required functionality and quality attributes), and deliver the product.(Team, 2010a).

Integrated e-government services such as e-health services (Sabr & Neamah, 2017) and public services in the form of web portals (Álvarez Sabucedo, Anido Rifón, Míguez Pérez, & Santos Gago, 2009) are intended for data automation (Kassim & Hussin, 2010) whether for government to business, government to other governmental or internal governmental entities in order to ensure continuity and efficiency in e-government processes is increasing.

4. Verification

The purpose of Verification (VER) is to ensure that selected work products meet their specified requirements (Team, 2010a). In accordance with the purpose of this CMMI-DEV process, the method of verifying the success of comprehensive e-government implementation can be implemented (Almarashdeh & Alsmadi, 2017).

Kharel (Kharel, Jha, Shakya, & Pokharel, 2014) uses the Fuzzy logic method to verify the challenges in e-government implementation. In addition to the challenges, every method of e-government development and e-government development planning also needs to be verified (Alshaikh et al., 2016) especially if e-government services involve interaction with other large-scale, distributed services for that verification stage to be a necessity in creating efficient, reliable security, and trusted by the public (Sun & Li, 2014).

5. Validation

The purpose of Validation (VAL) is to demonstrate that a product or product component fulfills its intended use when placed

in its intended environment (Team, 2010a). In the development of e-government that can be validated is a model of technology adoption with the intention of obtaining a technology adoption model that has an acceptable level of acceptability (Dwivedi et al., 2017). In addition to e-government services, validation can be made on the inherent framework of services to measure performance levels (Singh & Kar, 2017) and e-government maturity (Fath-Allah et al., 2016).

E. Synthesis of Results CMMI-SVC

Based on articles review, each CMMI-SVC process area had implemented in e-government application. The result of its review presented below:

1. Capacity and Availability Management

The purpose of Capacity and Availability Management (CAM) is to ensure effective service system performance and ensure that resources are provided and used effectively to support service requirements (Team, 2010b).

The availability of information and communication technology (ICT) infrastructure is one of five critical factors in the successful implementation of e-government services according to Zarimpas (Zarimpas, Grouztidou, & Anastasiadou, 2009) in addition to the political commitment to reform process, institutional capacity, the underlying legal framework related to electronic administration, and planning strategic about e-government.

Capacity building is applied to improve the capacity of government officials in mastering ICTs in line with the goal of promoting e-government (Margareta & Cornelia, 2013) as well as the agenda of transforming government processes into e-government (Margareta & Cornelia, 2013).

2. Service Continuity

The purpose of Service Continuity (SCON) is to establish and maintain plans to ensure continuity of services during and following any significant disruption of normal operations (Team, 2010b).

Continuous ICT services are a critical aspect of government institutions, to create an effective service continuity management system and ensure the sustainability of public services even in times of disaster, a combination of continuous planning and post disaster planning is needed (Koen, Von Solms, & Gerber, 2015). Cloud computing is one of the steps of migration of e-government services that can be taken in maintaining digital continuity (Kotka et al., 2016).

3. Service Delivery

The purpose of Service Delivery (SD) is to deliver services in accordance with service agreements (Team, 2010b). Providing services can not only provide services and communities that are actively seeking such services, but can also be developed into e-government services with a more proactive governmental concept of delivering public services (Linders & Wang, 2013).

Service delivery is an interaction between the two parties, the government as the service provider and the citizen as the recipient of the service, therefore further development of e-government services - in developing countries should immediately lead to a mechanism where citizen are involved in the development process (Dandjinou, 2007). Community involvement is assessed to improve the efficiency, success and interaction of citizens with their government (Pardhasaradhi & Ahmed, 2007).

Innovation to improve the delivery of e-government services has been made one of them mobile e-government (Bokhari & Khan, 2012) which became an alternative government in delivering its public services. In addition gamification is also one of the solutions that can be applied in the delivery of e-government services besides to promoting public awareness (Aljaaf, Al-Jumeily, Hussain, Alloghani, & Mustafina, 2017).

4. Incident Resolution and Prevention

The purpose of Incident Resolution and Prevention (IRP) is to ensure timely and effective resolution of service incidents and

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prevention of service incidents as appropriate (Team, 2010b).

Preventing failure in e-government implementation can be done with cultural changes made to the human element, organizational culture, and top management commitment (Lessa & Saravanan, 2014).

5. Service Transition

The purpose of Service System Transition (SST) is to deploy new or significantly changed service system components while managing their effect on ongoing service delivery (Team, 2010b). The transition of government services originally based on manual to digital (e-government) and now towards smart government is solely aimed at improving interoperability (Akatkin, Yasinovskaya, Drozhzhinov, & Konyavskiy, 2016).

The transition of government services can be in the form of a communication transition with its citizens such as one-way communication that originally became a model of e-government development, now a two-way communication involving social media. Communication by using social media has proven to increase the participation of public communications in receiving public services provided by the government (Halpern & Katz, 2012).

6. Service System Development

The purpose of Service System Development (SSD) is to analyze, design, develop, integrate, verify, and validate service systems, including service system components, to satisfy existing or anticipated service agreements. It is mentioned that the specific process in CMMI-DEV can also be measured in Service System Development (Team, 2010b)

In accordance with the purpose of Service System Development, the specific process that can be taken from the CMMI-DEV model such as Requirement Development (Alshaikh et al., 2016) (Rao et al., 2014) (Alexandrova, 2012) (Sabr et al., 2017), Product Integration (Sabr &

Neamah, 2017) (Álvarez Sabucedo et al., 2009) (Kassim & Hussin, 2010), Verification (Kharel et al., 2014) (Almarashdeh & Alsmadi, 2017) (Sun & Li, 2014) (Alshaikh et al., 2016), and Validation (Fath-Allah et al., 2016) (Singh & Kar, 2017) (Dwivedi et al., 2017).

7. Strategic Service Management Processes

The purpose of Strategic Service Management (STSM) is to establish and maintain standard services in concert with strategic needs and plans (Team, 2010b). The adoption of such a strategy in Taiwan is the e-government strategy of "service without boundaries" with the aim of providing a better life to the people (Linders & Wang, 2013) or which applied in Colombia with design strategies designed at the national and local levels and has been adapted by government agencies to in line with their organizational objectives (Parra & Mejia, 2010).

F. Summary of Evidence

Based on literature review, the author found that all the specific processes of the CMMI-DEV and CMMI-SVC models were used in e-government implementation which all specific process implemented at least in one e-government application. The most used is CMMI-DEV model, this evidence are shown in Table 2 and Table 3.

Tabel 2. Grouping articles based on specific CMMI-DEV process

Requirement Development	Technical Solution	Product Integration	Verification	Validation
(Alshaikh et al., 2016) (Rao et al., 2014) (Alexandrova, 2012) (Sabr et al., 2017)	(Alshaikh et al., 2016) (Estevez & Janowski, 2007) (Cenci, Estevez, & Fillottrani, 2017)	(Sabr & Neamah, 2017) (Álvarez Sabucedo et al., 2009) (Kassim & Hussin, 2010)	(Kharel et al., 2014) (Almarashdeh & Alsmadi, 2017) (Sun & Li, 2014) (Alshaikh et al., 2016)	(Fath-Allah et al., 2016) (Singh & Kar, 2017) (Dwivedi et al., 2017)

Tabel 3. Grouping articles based on specific CMMI-SVC processes

Capacity and Availability Management	Service Continuity	Service Delivery	Incident Resolution and Prevention	Service Transition	Service System Development	Strategic Service Management Processes
(Zarimpas et al., 2009) (Md Ariff Lim, Hwangbo, Kifle, & Kim, 2013) (Margareta & Cornelia, 2013)	(Kotka et al., 2016) (Koen et al., 2015)	(Linders & Wang, 2013) (Dandjinou, 2007) (Bokhari & Khan, 2012) (Pardhasaradhi & Ahmed, 2007) (Aljaaf et al., 2017)	(Lessa & Saravanan, 2014)	(Halpern & Katz, 2012) (Akatkin et al., 2016)	(Alshaikh et al., 2016) (Rao et al., 2014) (Alexandrova, 2012) (Sabr et al., 2017) (Sabr & Neamah, 2017) (Álvarez Sabucedo et al., 2009) (Kassim & Hussin, 2010) (Kharel et al., 2014) (Almarashdeh & Alsmadi, 2017) (Sun & Li, 2014) (Fath-Allah et al., 2016) (Singh & Kar, 2017) (Dwivedi et al., 2017)	(Linders & Wang, 2013) (Parra & Mejia, 2010)

Specific processes in the CMMI-SVC model have also been implemented but not as much as in CMMI-DEV, only on certain processes such as Capacity and Availability Management, Service Delivery, and Service System Development.

CONCLUSION

Limitations

The authors assume that all the specific processes in CMMI-DEV and CMMI-SVC can be used as a reference in assessing the maturity of e-government implementation, but the articles are considered less supportive of this assumption, especially in the CMMI-SVC specific process. An article search is needed not only from three repositories (IEEE Xplore Digital Library, ACM Digital Library, and ScienceDirect.com) to further support the argument.

Conclusions

Evidences explains that previous research had used minimum one or more specific process of CMMI-DEV and SMMI-SVC to measure maturity in e-government implementation. This is the proves that all specific process CMMI-DEV and CMMI-SVC can be used to measure implementation of e-government.

For optimum measurements it can use all the specific processes of CMMI-DEV and some CMMI-SVC specific processes such as Capacity and Availability Management, Service Delivery, and Service System Development. Other processes in CMMI-SVC (Service Continuity, Incident Resolution and Prevention, Service Transition, and Strategic Service Management Processes) can be considered in measuring the maturity of e-government implementation.

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