CLOUD ENTERPRISE RESOURCE PLANNING DEVELOPMENT MODEL BASED ON SOFTWARE FACTORY APPROACH

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Abstrak

Kajian literatur menunjukkan bahawa Perancangan Sumber Perusahaan Awan (Cloud ERP) telah berkembang dengan pesatnya. Namun, dari perspektif pembangun perisian, ia masih dibelenggu masalah seperti pengurusan yang kompleks, beban kerja yang tinggi, kualiti perisian yang tidak konsisten dan masalah pengekalan ilmu. Kajian terdahulu masih kekurangan penyelesaian yang holistik dalam menangani kesemua komponen masalah dalam kajian ini. Pendekatan Pengilangan Perisian (Software Factory) telah dipilih untuk disesuaikan dengan teori yang berkaitan bagi menghasilkan suatu model yang dirujuk sebagai Cloud ERP Factory Model (Model CEF), yang bertujuan untuk menyelesaikan permasalahan tersebut. Terdapat tiga objektif khusus dalam kajian ini iaitu (i) untuk membangunkan Model CEF dengan mengenalpasti komponen dan elemen terlibat dan mengabungkannya kepada persekitaran cloud, (ii) untuk menentusahkan pengagihan bagi kebolehsanaan teknikal Model CEF, dan (iii) untuk menentusahihkan medan kebolehgunaan penghasilan Model CEF dalam kajian kes sebenar. Kajian ini menggunapakai metodologi Sains Reka Bentuk beserta pendekatan penilaian kaedah campuran (Mixed Methods). Model CEF yang dibangunkan mengandungi lima komponen iaitu Barisan Produk, Pelantar, Aliran Kerja, Kawalan Produk dan Pengurusan Pengetahuan yang boleh digunakan untuk menyediakan persekitaran CEF CEF bagi mensimulasikan persekitaran produksi perisian berorientasikan proses dengan ciri-ciri perancangan sumber dan kapasiti. Model CEF ini telah ditentusahihkan melalui penilaian pakar, dan ditentusahkan kebolehsanaan teknikal nya dengan kejayaan pengagihan model ini kepada komersil terpilih bagi kemudahan produksi Cloud ERP. Tiga kajian kes untuk pengagihan Cloud ERP komersil telah dijalankan menggunakan persekitaran prototaip yang dibangunkan. Dengan menggunakan instrumen tinjauan yang telah dibangunkan, dapatan min skala Likert mencapai 6.3 daripada 7 mata keseluruhan yang menentupastikan model CEF adalah boleh digunapakai dan objektif kajian telah dicapai. Model CEF dan proses pengesahan pengagihan perisian Cloud ERP dalam persekitaran komersil melalui kajian kes sebenar merupakan sumbangan utama kajian ini. Kedua –dua sumbangan ini turut dapat digunakan oleh pengamal industri perisian dan ahli akademik sebagai rujukan untuk membangunkan kemudahan penghasilan Cloud ERP yang lebih mantap.

Kata Kunci: Perancangan Sumber Perusahaan Awan (Cloud ERP), Kilang Perisian, Senibina Berorientasikan Perkhidmatan (SOA), Litar Produk Perisian

Abstract

Literature reviews revealed that Cloud Enterprise Resource Planning (Cloud ERP) is significantly growing, yet from software developers' perspective, it has succumbed to high management complexity, high workload, inconsistency software quality, and knowledge retention problems. Previous researches lack a solution that holistically addresses all the research problem components. Software factory approach was chosen to be adapted along with relevant theories to develop a model referred to as Cloud ERP Factory Model (CEF Model), which intends to pave the way in solving the above-mentioned problems. There are three specific objectives, those are (i) to develop the model by identifying the components with its elements and compile them into the CEF Model, (ii) to verify the model's deployment technical feasibility, and (iii) to validate the model field usability in a real Cloud ERP production case studies. The research employed Design Science methodology, with a mixed method evaluation approach. The developed CEF Model consists of five components; those are Product Lines, Platform, Workflow, Product Control, and Knowledge Management, which can be used to setup a CEF environment that simulates a process-oriented software production environment with capacity and resource planning features. The model was validated through expert reviews and the finalized model was verified to be technically feasible by a successful deployment into a selected commercial Cloud ERP production facility. Three Cloud ERP commercial deployment case studies were conducted using the prototype environment. Using the survey instruments developed, the results yielded a Likert score mean of 6.3 out of 7 thus reaffirming that the model is usable and the research has met its objective in addressing the problem components. The models along with its deployment verification processes are the main research contributions. Both items can also be used by software industry practitioners and academician as references in developing a robust Cloud ERP production facility.

Keywords: Cloud Enterprise Resource Planning (Cloud ERP), Software Factory, Service Oriented Architecture (SOA), Software Product Line

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To family members; my parents Abd Jalil Abdullah and Siti Hasnah Johar, my wife Adelina and daughter Delilah, my siblings, relatives, and friends. I wish for this research to make you proud and happy. Cheers!

Table of Contents

List of Tables

List of Figures

List of Abbreviations

CEF	Cloud ERP Factory
IaaS	Infrastructure as a Service
PaaS	Platform as a Service
SaaS	Software as a Service
CQI	Continuous Quality Improvement
ERP	Enterprise Resource Planning
SPLE	Software Product Line Engineering
MDA	Model Driven Approach
SOA	Service Oriented Architecture
CRM	Customer Relationship Management
SCM	Supply Chain Management
UML	Unified Modeling Language
SF	Software Factory

List of Publications

The following is a list of the publications related to this research that have been published in journals and other proceedings.

JOURNALS

1. Jalil, Dzulkafli, Abu Bakar, Shahbani (2017). Adapting Software Factory Approach into Cloud ERP Production Model. *International Journal of Computer Science and Information Security*, *15*(1)
2. Jalil, Dzulkafli, Abu Bakar, Shahbani (2017). Enabling Software Factory with Job Workflow. *International Journal of Computer Science and Information Security*, *15*(4)
3. Muhamad Shahbani Abu Bakar, Dzulkafli Jalil, Zulkifli Mohamed Udin (2017). Knowledge Repository: Implementing Learning Management System into Corporate Environment *International Conference on Applied Science and Technology*, *8*(8) JTEC
4. Jalil, Dzulkafli, Shahbani Abu Bakar, Mohd Khir, Mokhzani Fauzi (2017). Integrated Facility Platform for Next-Gen Aircraft Maintenance, Repair and Overhaul (MRO). *International Journal of Computer Science and Information Security*, *15*(5)

PROCEEDINGS

1. Muhamad Shahbani Abu Bakar, Dzulkafli Abd. Jalil, Azman Ta'a1, Zulkifli Md. Udin, Said Ashari (2017). Adapting Learning Management System into Corporate Environment: Knowledge Repository in Cloud Enterprise Resource Planning Software Provider . *3rd National Conference on Knowledge Transfer*, *17*(1)
2. Muhamad Shahbani Abu Bakar, Dzulkafli Jalil (2017). Corporate Knowledge Repository: Adopting Academic LMS into Corporate Environment. *International Conference on Applied Science and Technology, 17(4)*

Awards and Recognitions

1. Grant Knowledge Transfer Program, Implementation of Cloud Enterprise Resource Planning. Ref No: I-ECO/44(UUM-15)/Code SO:13211/Project Cost: RM 143, 086.00.

2. SILVER Medal, IUCEL 2017, International University Carnival, Cloud Learning Management System (LMS) in Corporate Environment. 26-27 Sept 2017, University Sains Islam Malaysia.

CHAPTER ONE
BACKGROUND OVERVIEW

1.1 Overview

The first chapter offers a brief overview of the research, which focuses on the data that lead to the motivational aspect of the research, specifications of the problem, extraction of research gaps with research questions, and the formulation of research objectives. The scope and limitations of the research and its expected contributive elements will be clearly defined. The research theoretical framework diagram will describe the theoretical approach of the research. Finally, operational terminologies and the overall thesis structure utilized will be explained.

1.2 Background Study

Enterprise Resource Planning (ERP) is undoubtedly a critical component of any business operation, thus making it almost a mandatory requirement to set up a business (Panorama Consulting Solutions, 2016). ERP refers to an enterprise business strategy and a set of industry-domain-specific applications that promote customer and shareholder value by enabling and optimizing collaborative operational and financial processes (Bond, Genovese, Miklovic, Zrimsek, & Rayner, 2005). The term ERP was initially defined by Gartner in 1990 and was later revised to the term ERP II in 2000, which expanded the scope to include almost every business facet within an organization. Figure 1.1 illustrates a typical commercial ERP package.

The contents of the thesis is for internal user only

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APPENDICES

A - EXPERT REVIEW FORM

VALIDATION FORM

Purpose of expert review:

The objective of this document is to get assumptions and expert judgement with regards to a new proposed model entitled "**Cloud ERP Factory**". This is a new proposed model that can be used as a blueprint for Cloud ERP Production environment to reduce the complexity of managing Cloud ERP deployment, manage the workload of developers and improve software quality inconsistency with knowledge retention capabilities. The input and feedback from this exercise will be used to enhance and validate the proposed model.

Expert/Reviewer Information

Name : _____

Age : 30 – 39 years [ ] 40 – 49 years [ ] 50 – 59 years [ ]

Gender : Male [ ] Female [ ]

Affiliation : _____

Working Experience : _____ years

Position: : _____

Items to Review

Enclosed with this validation form is the proposed model entitled "Cloud ERP Factory" (Refer to Figure 1. In Page 3). Please validate based on the Likert Scale provided below:

1 – Strongly Disagree
2 – Disagree
3 – Somewhat disagree
4 – Undecided
5 – Somewhat agree
6 – Agree
7 – Strongly Agree

If the identified factors and elements is inappropriate or unclear, please comment, suggest, and edit accordingly. Your kind help and feedback is greatly appreciated.

Thank you.

Dzulkafli Jalil

1. **The CEF Model is easy to understand. (Understandability)** [ ]
2. **The CEF Model provided a clear steps and procedures to follow. (Clear steps)** [ ]
3. **The CEF Model is relevant to the software production environment of Cloud ERP. (Relevancy)** [ ]
4. **The CEF Model is able to support the needs for future Cloud ERP production environment. (Flexibility)** [ ]
5. **The CEF Model is able to be implemented based on the needs of an organization without having to add additional resources. (Scalability)** [ ]
6. **The data flow of the CEF Model is reliable and accurate. (Accuracy)** [ ]
7. **The CEF Model describes a complete Cloud ERP production lifecycle which can be applied by other Cloud ERP providers. (Completeness)** [ ]
8. **The CEF Model is able to act as a consistent information source to allow for decision making support. (Consistency)** [ ]
9. **The CEF Model is able to be applied in the future and in different context. (Timeless)** [ ]

10. Please provide any other comments or suggestions to improve the proposed model.

_____

_____

_____

_____

_____

_____

_____

B – VERIFICATION CHECKLIST

CEF Model Verification Checklist

Component	No	Checklist Description	Tick Box
CEF Product Line	1	The product line grouping should cover intended product family and its sub product as well as future product can be fit into of the product family.	
	2	Important and common ERP modules should be defined and grouped as Core Module.	
	3	Model can be deployed to customer individually or in integrated mode (loosely coupled).	
	4	Core system, industry solutions and legacy can be integrated with standard interface protocols.	
	5	Future upgrades for one particular product should not affect the other system through backwards compatibility.	
	6	Each product has its own configuration parameter.	
CEF Platform	7	All product should fit in a common platform which has built-in product components.	
	8	All product information is systematically through a system.	
	9	Audit process and enforcement model are available.	
	10	The product line grouping should cover intended product family and its sub product as well as future product can be fit into of the product family.	
	11	It should be able to integrate with existing legacy product through API.	
	12	Model can be deployed to customer individually or in integrated mode (loosely coupled).	
	13	Future upgrades for one particular product should not affect the other system through backwards compatibility.	
	14	Each product has its own configuration parameter.	
CEF Workflow	15	The jobs can be across the department depending on the responsibility the task performed.	
	16	Each department need to have their own department specific job complete with checklists.	
	17	Each job can be used for other department's Work Template.	
	18	Upon confirmation of a Work Order, work order template will be used to distribute the jobs assigned to the designated staff within the system.	

	19	Each task should carry its own time frame to allow for tracking of progress and at which task.	
CEF Product Control	20	Part number generation must be done with the event of new product released. (Concurrent only with a sale of a new product).	
	21	Product database should contain all documentation which includes product specification, release notes, system algorithm and actual coding files.	
	22	Each product development owner is responsible for the release of the developed product.	
	23	Serial number activation is required to allow for keeping tabs on the number of products being sold and/or deployed to clients.	
CEF Knowledge Management	24	The knowledge creator has full power over the content of the knowledge provided.	
	25	The updates of contents, training materials, guides, and related documentation are conducted by the administrator, through the main knowledge management engine.	
	26	Able to ensure knowledge retrieval and logging through procedures in the system	
	27	The system ensures that all knowledge can be referred to from a single focal point i.e. dashboard.	

C - SURVEY INSTRUMENT

CLOUD EFP FACTORY MODEL

FIELD DEMONSTRATION SURVEY FORM

UNIVERSITI UTARA MALAYSIA

NAME:

DESIGNATION: **DATE:**

CASE STUDY NO:

Please circle your answer in the scale of 1 to 7 according to the below questions.

No	PERCEIVED USEFULLNESS	Scale Rating								
1	Using the CEF system environment in my job would enable me to accomplish tasks more quickly	Unlikely	1	2	3	4	5	6	7	Likely
2	Using the CEF system environment would improve my job performance	Unlikely	1	2	3	4	5	6	7	Likely
3	Using the CEF system environment in my job would increase my productivity	Unlikely	1	2	3	4	5	6	7	Likely
4	Using the CEF system environment would enhance my effectiveness on the job	Unlikely	1	2	3	4	5	6	7	Likely
5	Using the CEF system environment would make it easier to do my job	Unlikely	1	2	3	4	5	6	7	Likely
6	I would find the CEF system environment useful in my job	Unlikely	1	2	3	4	5	6	7	Likely
	PERCEIVED EASE OF USE	**Scale Rating**								
7	Learning to operate the CEF system environment would be easy for me	Unlikely	1	2	3	4	5	6	7	Likely
8	I would find it easy to get the CEF system environment to do what I want it to do	Unlikely	1	2	3	4	5	6	7	Likely
9	My interaction with the CEF system environment would be clear and understandable	Unlikely	1	2	3	4	5	6	7	Likely
10	I would find the CEF system environment to be flexible to interact with	Unlikely	1	2	3	4	5	6	7	Likely
11	It would be easy for me to become skilful at using the CEF system environment	Unlikely	1	2	3	4	5	6	7	Likely
12	I would find the CEF system environment easy to use	Unlikely	1	2	3	4	5	6	7	Likely

No	ADDITIONAL QUESTIONS	Scale Rating								
1	The CEF system environment was able to reduce my daily workload compared to previous method	Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree
2	The CEF system environment was able to improve the overall management of workload in the company compared to the previous method	Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree
3	The CEF system environment was able to maintain the software quality being developed compared to previous method	Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree
4	The CEF system environment was able provides better step by step procedures to ensure consistency compared to previous method.	Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree
5	Managing Cloud ERP solution is easier compared to the previous method.	Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

6	The CEF system environment has provided me with easier management tools for my work compared to the previous method.	Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree
7	I am able to execute my task with the help of the CEF knowledge management system compared to previous method.	Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree
8	The CEF system environment was able to provide better knowledge retention compared to previous method.	Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

GROUP:

NEGATIVE COMMENTS

POSITIVE COMMENTS