Agile Methods for ERP Implementation: A Systematic Literature Review

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Abstract – **Since ERP solution facilitates has changed in business environment and also has helped in supporting managerial level to make decision. Therefore, ERP system is important strategy for organization's survival. One of the critical issues that affect a successful ERP implementation is the implementation method. In previous research, it showed that many organizations had faced complexity when they were implementing ERP in order to meet their requirements. In other cases, the ERP systems are unable to provide solution which is a simplicity of the necessary business processes. The ERP implementation complexity is one of the factors that lead the failures. Thus, here, we intend to propose an agile approach to reduce complexity and eventually our intention is to improve ERP implementing to become more successful. In this study, we are employing a systematic literature review (SLR) approach to identify the principles factors of the agile methods for ERP implementation. In result of employing this SLR method, we found that agile values and principles are correlated in ERP implementation complexity.**

Keywords–*complexity, agile methods, ERP implementation, systematic literature review*

I. INTRODUCTION

Lately in recent decades, the purpose of ERP investment has showed as an important strategy of the organizations for ensure reaching competitive advantage and enhancing the performance of the organizations. ERP system has proved to be the best solution to help the managerial level to decision-making, but a costly mistake for many others [3]. Information systems are important tools for improving productivity. Therefore, management of organizations has commitment and support for the investment of ERP projects. In reality, many organizations have encountered the complexity and they even have failed to implement ERP. It is important for management of organizations to know the main issues of the complexity of ERP implementation. The main issues are the critical factors that affect the success rate of the ERP implementation. Therefore, the organizations are finding the complexity in ERP implementation. It is found that the effects of such complexities are more than 90% over budgets and 72% ERP implementation can't fulfill the time constraint. The result of ERP implementation success is below 30%, and approximately 20% ERP implementation is the failure [19]. The ERP implementation is venturous, complicated and timeframes. The customizing is considered one of the most precarious matters when ERP implementation is done [14]. The ERP implementation failure has an urge for the new method of facing the misalignment problem [8]. Project management factors become one of the main problems and contribute to failure or success in implementing ERP [10]. The customization issues affect the increase the risk of ERP implementation complexity. Additionally, the methodology of implementation is the important tool that must be considered for reducing the complexity of ERP implementation. An agile development has contributed to describe the decision process in customizing in ERP development in the organizations environment [1].

The purposes of this research were to serve three goals. First, was to identify the main issues of the ERP implementation complexity. Second, the research would propose the main issues of agile method and the ERP implementation complexity. Third, the research would propose the correlate agile methods and the

ERP implementation complexity. The research questions that were explained in the review are:

1. What are the main issues that affect the ERP implementation complexity?
2. Are the agile methods and the ERP implementation complexity concerned with the same issues?
3. How do we determine the correlation between the agile values and principles and the issues found in ERP implementation complexity?

II. LITERATURE SEARCH

A. ERP implementation approach

ERP implementation projects are complex, risky and expensive. Accordingly, it is quite precarious of failure [34]. Many ERP implementation projects still depend on the using of traditional waterfall methodologies. ERP implementation success depends on choosing the implementation approach by the organization [14]. The common implementation approaches are traditional waterfall approach and an agile approach. In a waterfall approach, the process of implementation is not effective: on the other hand, in agile approach, the process implementation is incremental or phased way and iterative, focusing on time delivery, simplicity, and fast response. The traditional method requires a long time in project planning [32]. ERP implementation phase is a complex process that potentially results in serious failures [2]. ERP implementation will describe business processes, and use a prototype-iterative approach that was based on the agile approach [35].

B. ERP implementation complexity

The complexity is a significant concern and can increasingly undermine the performance of operational, but with the improvement of technology, complexity is associated with the resources to develop the quality of products [17]. The ERP implementation complexity does not face technological issues only but also face in the organizational factors and other factors. [40]. The ERP implementation project is critical and complex [16]. The ERP projects are complex projects that consist of multiple sub-projects, such as mapping of business processes requirements, development of infrastructure technology, business processes change [14]. The ERP implementation success depends on the integration with applications that affect the organizations. The ERP systems have characterized a high rate of the business process complexity, data integrate, and functionality that affects the increase of the business processes complexity [37]. The ERP system is a complex application and that is due to depending on the business process, and it is known as best practices and the main reasons ERP project failures are project management issue, business process change during the project implementing, and management support issue [5]. The complexity of ERP implementation is the task and system complexity. Task complexity is known as the uncertainty that defines the best practice in business. Besides that, System

complexity is known as the uncertainty that defines the best practice in systems development [40]. The ERP systems have the risk of failure because of the increasing complexity of organization's business processes and scale of operations [35]. Additionally, the organizations need the ERP implementation because of some factors such as company growth, information need, new functionality, reorganization, updating project reporting, and business process integration for support management. The complexity is not only in specialized publications but also in methodologies used to manage ERP projects [15]. The ERP projects are a complex system in project development which 35% of ERP implementations cancel, 70% of ERP implementations fail, 178% over budget and only 30% of ERP implementations delivered [2]. The complexity has affected the behavior and performance of the key users, so to reduce the complexity, needed other method approach to solve these gaps [36].

TABLE I.   COMPLEXITY OF ERP IMPLEMENTATION [25]

Complexity Type	Difficult to use	Difficult to understand	Difficult to manage	Difficult to implement	Potential to increase	Frequency
Lack of change management		√				1
Internal resource unavailability				√		1
Lack of business sponsorship				√		1
Process duplication			√		√	2
Poor integration			√	√		2
Resistance to change			√	√		2
Problematic implementation sequence	√		√	√		3
Poor training	√	√	√			3
Poor business process understanding	√	√		√		3
Subtantial customization	√		√	√	√	4
Poor process standarization	√	√	√	√		4
Poor business process integration	√		√	√	√	4
Poor end to end process design	√	√	√	√	√	5
Poor understanding of ERP solution	√	√	√	√	√	5
Poor data quality	√	√	√	√	√	5

Table 1. indicates that the main issues of the ERP implementation complexity need to focus seriously on process design, understanding of ERP solutions, data quality, customization, process standardization, and business process integration because these factors have critical factors in reducing the complexity of ERP implementation.

C. Agile methods of literature review

Another factor to consider in ensuring reduce the ERP implementation complexity is methodology. The methodology is to reduce information system complexity [15]. The agile approach is one of methodology that is considered for reducing the ERP implementation complexity. The Agile method started to appear in 2001 to develop incremental, iterative development and methods principles [34]. Agile methods were designed to manage change more efficient [12]. The component of the agile approach shown in table 2.

TABLE II. AGILE APPROACH - ADOPTED FROM [12]

Components	Factors
Quality assurance challenges	Accommodating non-functional testng Lack of automated testing Requirements ambiguity affects quality assurance
Integrating non development functions	Other functions unwilling to change Challenges in adjusting to incremental delivery pace Bewarding model not teamwork centric Challenges in adjusting product launch activities
Management Support	Ensure management support Enducate management on agile Make management support visible
Commitment to change	Communicate that change is non negotiable Show strong commitment
Leadership	Recognize the importance of change leaders Engage change leaders without baggage of the past
Choosing and customizing	Customize the agile approach carefully Conform the a single approach Map to old way of working to ease adaptation, Keep it simple
Piloting	Start with a pilot to gain acceptance Gathering insights from a pilot
Training & coaching	Coach teams as they learn by doing Provide training on agile method
Engaging people	Engage everyone in the organization Start with agile supporters Include persons with previous agile experience
Communication & transparency	Create & communicate Communicate the change intensively, Make change transparent
Mindset & alignment	Align the organization Concentrate on agile values Arrange social events, Cherish agile commnities
Team autonomy	Allow teams to self organize Allow grass roots level empowerment
Requirements management	Recognize the importance of the product owner role Invest in learning to refine the requirements

D. Agile methods and ERP implementation

Agile methodologies are the focus in incremental and iterative that effect in order to divide the function into smaller ones, so the development cycle becomes shorter while traditional waterfall methodologies focus on trick change management [34]. The agile methods in the ERP implementation will build on the premises which more the focus to achieve communication efficient [8]. The benefits of the agile method for ERP implementation have a significant impact to enhance the ERP implementation success [34]. Therefore, implementing ERP with the agile approach can break projects into limited iterations and time-boxed to quick monitoring. ERP systems are integrated with the business process into one single system. So ERP implementation can increase the resistance to change. Therefore, ERP implementation should have a systematic approach to manage the complexity of ERP implementation [14]. The agile approach can reduce the failure of ERP implementation [35]. It can be concluded that agile methods and ERP implementation have a correlation because both methods can achieve their goals in improving quality of the projects.

III. RESEARCH METHOD

In this section, the research methodology used for conducting the literature review is presented. This research employs the SLR on the parameters defined by [21].

A. Search terms

The keyword used to search terms for papers, we determined the search string are as follows:
a. ("complexity") AND ("ERP" OR "implementation")
b. ("agile") AND ("methods")
c. ("agile") AND ("framework" OR "ERP" OR "implementation")

The complete string used in the search was: 1 AND 2 AND 3

B. Search process

The search process was presented by online databases which included references for papers of conference proceedings and journals between the year 2002 and 2018. The search process was used online database for finding the papers related.

C. Study selection

We determined a set of selection inclusion criteria exclusion criteria to select the appropriate papers for the answer to research questions. The inclusion criteria used on the literature are listed below:
a) The criteria of studies are the agile ERP topic.
b) The papers published between the year 2002 and year 2018.
c) The conference and journals only.
d) The collection of data from the general online database sources.
e) The papers that based on qualitative analysis or quantitative analysis or a mix both.

The exclusion criteria used to explain based on the literature are as follows:
a) The title is not related to this study.
b) The papers are publication before the year 2002.
c) The papers have a weak analysis such as papers redundancy, editorial paper, master thesis, unpublished paper, opinion, panel discussion, technical reports, etc.
d) The paper is non-academic databases or is a book.
e) The paper is not written in English.

D. Data collection

The data collection is done by title, keywords, abstracts, and full-text analysis for determining design forms that the finding information of the papers selected. The search result was processed by using the following processes as follows:
a. Papers found: Papers were found based on predetermined keywords related to this research.
b. Candidate papers: Paper is made by review the title, keywords, and abstract.
c. Select papers: Paper is made by review the full text of the papers.

TABLE III. THE SOURCE OF STUDIES SELECTED

Source	Papers Found	Candidate Papers	Select Papers
ACM digital library	797	18	4
Elsevier	1,325	58	6
Emerald Insight	529	27	4
IEEE Digital Library	16	19	4
Scopus	37	16	-
Springer Link	734	12	3
Taylor & Francis Online	801	18	3
Wiley Online Library	170	8	1
Other	95	95	11
	4,504	271	36

After process studies selected, we have selected papers from 36 papers that will be the primary paper of this research, that the categories papers are 18 papers selected from the journal and 18 papers selected from conference proceeding. The primary

papers were processed for the mapping answer the research questions. The summary of data extraction shown in table 3.
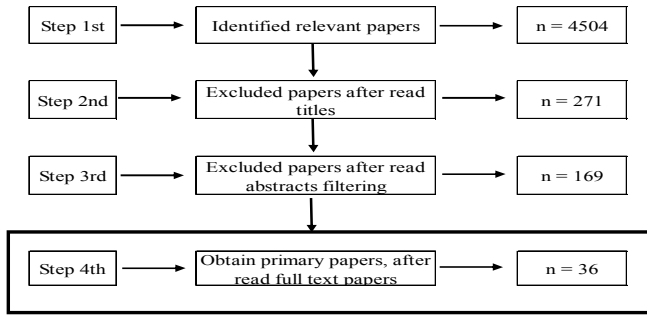

Fig. 1. Study step of process

On figure 1, we have reviewed all papers by keyword, title, and abstract that is the mapping for suit by the inclusion criteria. Step1, from 4504 papers recognize relevant were selected papers for review with detail. Step2, we have selected 271papers as candidate papers. Step3, based on the review of abstract, we have selected 169 papers for review with detail. Step4, Based on full-text papers, we have fond 36papers as primary papers for the processing data to mapping and answer the research questions.

E. Empirical studies and data analysis

Based on the primary papers, the researcher determined papers as empirical research by analyzed papers. The result empirical research shown in table 4.

TABLE IV.   EMPIRICAL RESEARCH BY ANALYZED PAPERS

No of papers	Descriptions	%
25	Case Study	69%
5	Systematic Literature Review	14%
3	Survey	8%
3	Experiment	8%
36		100%

Table 4 indicates that the results process shows that the main papers have categorized in the case study (69% or 25papers). It will make data analysis results to be close the real case study on the business for the answer to research questions.

IV. RESULT

In this section, the researchers have examined for the mapping activity for the answer of research questions.

A. Search results

We have processed 36 papers as primary paper. The result of the process based on the literature systematic review, such as id paper, authors, focus research, paper publication date is shown in table 5.

TABLE V.   SYSTEMATIC REVIEW STUDIES

Id Paper	Authors	Agile Methods	ERP implement	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
id01	Alleman, 2002	√		√																
id02	Amid et al., 2012	√	√											√						
id03	Baig et al., 2017																			√	
id04	Bansal & Negi, 2008									√											
id05	Baramichai et al., 2007	√								√											
id06	Campanelli et al., 2015	√															√				
id07	Carvalho et al., 2009	√										√									
id08	Chang, 2010	√											√								
id09	Chen et al., 2009	√										√									
id10	Conboy & Fitzgerald, 2004	√				√															
id11	Dikert et al., 2016	√																√			
id12	Fetouh et al., 2011	√												√							
id13	Ghosh & Skibniewski, 2010												√								
id14	Holub, 2016	√																√			
id15	Hussain et al., 2018	√																			√
id16	Jacobs, 2013														√						
id17	Jovicic et al., 2012	√												√							
id18	Kaushik et al., 2015	√															√				
id19	Khatri et al., 2018	√																			√
id20	Laurie et al., 2017	√																		√	
id21	Mishra, 2011	√												√							
id22	Moon et al., 2017	√																		√	
id23	Nerur et al., 2005	√					√														
id24	Patil, 2015	√															√				
id25	Peci & Vazan, 2014	√													√						
id26	Ribbers & Schoo, 2002			√																	
id27	Saeed et al., 2017																			√	
id28	Salvador et al., 2014	√													√						
id29	Shaydulin & Sybrandt, 2017	√																		√	
id30	Suomalainen et al., 2015	√															√				
id31	Tarea, 2016	√																√			
id32	Tribka & Soja, 2014														√						
id33	Tripp & Armstrong, 2018	√																			√
id34	Uflacker & Busse, 2007								√												
id35	Uppstrom et al., 2015																√				
id36	Valdeza et al., 2015																√				
	Total	20	16	2	0	1	1	0	2	1	2	2	2	1	3	6	3	5	3	

Table 5 shows which the number of papers with the focus on studying agile methods are 20 papers, and focus the complexity of ERP implementation are 16 papers.

B. Main issues of the agile methods found through the literature review

The result investigation of the primary papers indicates that the main issues of agile methods are strategies (22%), agile project management (20%), systems (10%), process (10%), management/leadership (9%), methodology (9%), technologies (7%), people (8%), organization (5%). The listed below on table 6 shown with sub-factors of agile methods identified through literature review.

TABLE VI.   AGILE METHODS IDENTIFIED THROUGH LITERATURE REVIEW

The main issues	No	Factors of agile methods	Total
Strategies	1	Virtual enterprise	1
	2	Supply chain	1
	3	Concurrent engineering	1
	4	Flexibility & adaptability to changing environment	6
	5	Interative & Incremental phared	3
	6	Improve business value	1
	7	Reduce complexity	4
	8	Focus on customer needs	1
	9	Focus on delivery functional	1
Agile Project Management	10	Project management & project planning	7
	11	Project champions	4
	12	Rapid product development	2
	13	Reduce development time	1
	14	Reduce project schedule	1
	15	Reduce testing time	1
	16	Best practices	1
Systems	17	Design systems	1
	18	Production planning & control systems	1
	19	Minimal customization	1
	20	Improve the quality of systems	4
Process	21	Business Process Reengineering	5
	22	Reduction in waste/excess activities	4
Management /Leadership	23	Change management plan	2
	24	Simplicity, Fast, Deliver operating	3
	25	Communication & fast response to changes	3
Methodology	26	Develop methods (team, environment, objective)	7
	27	Agile methods for Software development	
Tech-nologies	28	Hardware tools and equipment IT	1
	29	Changing technologies & Enterprise integration	4
	30	IT & Communication	1
People	31	Top management support & employee	2
	32	Knowledge workers	1
	33	Use of consultants & vendor's	1
	34	Training and Coaching	3
Organization	35	Organizational change, structural & cultural	4
		Total	8 4 1 3 3 3 3 3 4 4 9 2 5 8 10 3 2 3 3 14

Table 6 indicates that the component factors agile methods are strategies, project management, systems, process, management, methodology, technologies, people, and organization.

C. The main issues of the ERP implementation complexity found through the literature review

Based on the result analysis identified through the iterature review, we show that the main issues of the complexity of ERP implementation are project management, management / leadership, technology, organization, process, people, technical, external, and methodology. These factors have the significant impact to reduce the ERP implementation complexity.

TABLE VII. THE MAIN ISSUES OF THE ERP IMPLEMENTATION COMPLEXITY IDENTIFIED THROUGH LITERATURE REVIEW

The main issues	No	Factors	Total	Bansal & Negi, 2008	Tareq, 2016	Ghosh & Skibniewski, 2010	Amil et al., 2012	Upstrom et al., 2015	Chen et al., 2009	Saeed et al., 2017	Patil, 2015	Laurie et al., 2017	Peci & Vazan, 2014	Holub, 2016	Valdeza et al., 2015	Ulbacker & Busse, 2007	Jacobs, 2013	Ribbers & Schoo, 2002	Hussain et al., 2018
Project Management	1	Project management & project planning	9	√		√	√	√		√			√						√
	2	Too tight project schedule	3	√								√							√
	3	Risk management	1				√												
Management /Leadership	4	Top management support	8	√	√	√		√		√	√	√							
	5	Adequate change management	2		√	√													
	6	Funds	1	√															
Systems	8	More customization	4		√	√	√								√				
	9	Data fill-in (Inaccurate data)	2		√	√													
	10	Adequate selection of application	2		√											√			
	11	Performance measurement system	1								√								
Organization	7	Organizational Change	6	√		√				√	√	√							
Process	12	Business Process Reengineering	6	√	√	√		√			√		√						
People	13	Right people on the team	3				√			√		√							
	14	Adequate education and training	2	√	√														
External	15	Effective external consultant	3		√			√			√								
Technology	16	Innovatif technology	2			√					√								
Methodology	17	Framework for ERP implementation	2							√									√
		Total	57	3	6	7	9	3	3	4	4	3	6	1	1	2	1	2	2

V. DISCUSSION

In this section, the researchers have shown the result of mapping for the answer of research questions.

A. What are the main issues that affect the ERP implementation complexity?

The result investigation of the primary papers indicate that the main issues of the complexity of ERP implementation are project management (23%), management/leadership (19%), systems (16%), organization 11%), process (11%), people (9%), external (5%), technology (4%) and methodology (4%). The summary main issues of the complexity of ERP implementation.

B. Are the agile methods and the ERP implementation complexity concerned with the same issues?

Based on the result analysis, we show that the main issues of the agile methods are strategies, agile project management, systems, process, management/leadership, methodology, technologies, people, and organization. These factors have the significant impact to ensure information system project success. The main issues detail of the agile methods shown in table 8.

TABLE VIII. THE SUMMARY MAIN ISSUES OF THE AGILE METHODS FOUND THROUGH LITERATURE REVIEW

The main issues	# Papers	%
Strategies	19	22%
Agile Project Manager	17	20%
Systems	9	10%
Process	9	10%
Management /Leadership	8	9%
Methodology	8	9%
Technologies	6	7%
People	7	8%
Organization	4	5%
		100%

The comparison of main issues between the ERP implementation complexity and the agile methods that indicate the main issues are the same with the focus of achieving information system project success. It can be concluded that the agile methods have the significant impact to reduce the complexity of ERP implementation.

C. How do we determine the correlation between the agile values and principles and the issues found in ERP implementation complexity?

Based on the result analysis, we show that the same main issues between the ERP implementation complexity and the agile methods are project management, process, management/leadership, methodology, technologies, people, and organization. These factors have the significant impact to ensure information system project success. The project management is the key factors that significantly effect to achieve the project's success. The comparison between agile methods and ERP implementation complexity shown in table 9.

TABLE IX. COMPARISON AGILE METHODS VS ERP IMPLEMENTATION COMPLEXITY OF

The main issues	Agile methods		ERP implementation complexity	
	# of papers	%	# of papers	%
Strategies	19	22%	-	0%
Project Management	17	20%	13	23%
Systems	9	10%	9	16%
Process	9	10%	6	11%
Management /Leadership	8	9%	11	19%
Methodology	8	9%	2	4%
Technologies	6	7%	2	4%
People	7	8%	5	9%
Organization	4	5%	6	11%
External	0	0%	3	5%
		100%		100%

D. The limitations and future research

This research identifies the main issues of ERP implementation complexity and agile methods based on SLR approach for general organizations, and the limitation on the industry sample. Therefore, the researchers have understood that this research has a limitation and need to be improve the future research to proving with the real case in business by focusing on case studies and conducting survey of many different industries as the objects for developing of the agile framework for ERP implementation.

VI. CONCLUSION

The resulting analysis indicates that the implication for the organizations is more understandable and about the main issues of the agile methods and the ERP implementation complexity become an important strategy to consider in helping the managerial level of organizations before they make the decision to implement the projects. The research has given the contribution that is to find potential which the agile methods as approach methods and can be considered as the solutions to reduce the ERP implementation complexity. The main issues of the agile methods are strategies that give contribution and

support in reducing the ERP implementation complexity. The strategies factors of agile methods are as follows: virtual enterprise, supply chain, concurrent engineering, flexibility and adaptability of changing the environment, iterative and incremental phased, improve business value, and reduce complexity, customer needs, and delivery functions. These factors have the significant strategy to reduce the ERP implementation complexity.

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