Project Management Methodologies for Engineering KMS based on PMBOK Approach: A Systematic Literature Review

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Abstract— **The process of creating, sharing, discovering, and capturing knowledge becomes an intangible asset for an organization. As a valuable asset, Knowledge needs to be managed. There is a tool called Knowledge Management System (KMS). The latest technology and social or structural mechanisms are components to develop KMS. But developing an IT project has a high risk of failure, so it should be managed using a project management approach. A project is a temporary endeavor to make a product or service. It means that a project has a start and an end project phase. Some methodologies which exist do not offer complete stages of development KMS. They do not cover feasibility study activities, lack of clear specification, and lack of closing project phase. The study gap is expected to be loaded up and well explained in this paper through a systematic review of the published literature over the last six years using the Kitchenham method. The results show that most researchers used a predictive approach compared to an iterative, incremental, or adaptive development approach to build KMS. The main result of this study we found 36 processes in the developing KMS. The novelty of this research, we generated a table to map the processes into the model, method, artifact and presented it by group process based on the Project Management Body of Knowledge (PMBOK). The table can help the organization develop the KMS project to improve its effectiveness and competitiveness.**

Keywords—— **KMS, methodologies, framework, knowledge management system**

I.   INTRODUCTION

Knowledge Management (KM) can improve the organization's effectiveness and competitiveness through every organization's employees [1]. Using KM, every employee can create, use, capture, and share knowledge to improve learning and performance within the organization. KM is a solution that can increase intellectual specialization and the ability of an employee to make better and faster decisions in complex situations, even in light of lack of experience [2].

KM needs to be managed by the organization. But Covid-19 pandemic became a massive obstacle for KM because everybody must work from home and can not access the organization's knowledge. Knowledge Management System (KMS) is a solution for that case. The interaction of cutting-edge technologies and socio-structural factors is characterized as KMS [2].

Organizations must establish KMS. Developing a KMS is not an easy task due to the multitude of variables involved. The importance of social variables outweighs the importance of technological elements. Thus a robust, comprehensive methodology or framework needs to be built and managed with a good project management approach [3].

Developing an IT project has a high risk to be failed. Data from CHAOS, Report from The Standish Group on IT project success rates showed that in 2015-2020 failure rates within the IT project have been high. IT project failure rate is approximately 19%, project success is 35%, and project challenge is 46% [4]. Successful means project meets the required functionality, on time as expected date, and matched planned cost. The challenged term means the project is completed but offers fewer features, over the time estimate, and over-budget. Failed means the project is not completed and broken at some point in the development cycle [5].

The Standish Group collected from 2,500 to 5,000 IT project cases every year. Over 25 years, they showed Metrix as fig 1. Organizations need to manage KMS development projects using a project management approach to reduce the risk of failure. In 2021 Project Management Institute (PMI), as a professional organization for project management, proposed the seventh version of the Project Management Body of Knowledge (PMBOK) guide. PMBOK shows approaches to manage projects and deliver project outcomes effectively and successfully wheater it uses predictive, agile, adaptive, traditional, or hybrid development approaches [6].
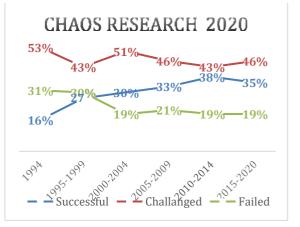

Fig. 1. CHAOS Research on IT project failed presentation [4]

A project is a short/long-term endeavor to create a product, service, or outcome. [6]. It means that a project has a start and an end project phase. Some methodologies which exist do not offer complete phases of development of KMS. They do not cover feasibility study activities, lack of clear specification, lack of validation phase, or lack of KMS development process. For example, research [7] proposed a methodology for implementing KMS 2.0 in an Oil and Gas Company. This research suggested 7 phases in methodology. They are draft, planning, analysis, design, development, implementation, and control phases, but the proposed methodology does not include the KM Process. Modeling KMS using a hybrid soft system methodology (SSM) and the Becerra approach [8] only focused on feasibility and design analysis but lacked from the build, test, deploy, and closing the project phases.

With a systematic literature evaluation in the last six years utilizing the Kitchenham approach, the study gap is predicted to be loaded up and fully described in this paper. The novelty of this research We provide a table to map the development process into the model, method, artifact and present it by group process based on the Project Management Body of Knowledge (PMBOK) to help the organization develop the KMS project to improve the effectiveness and competitiveness of the organization.

II. THEORETICAL OVERVIEW

A. Knowledge Management

There are two types of knowledge: tacit and explicit. Tacit means knowledge is difficult to express and formalize because it is based on individual experiences such as insight, intuitions, and hunches (instinct), whereas explicit means opposite of the tacit [2]. Those knowledge are used to create new knowledge by acquiring, representing, exchanging, maintaining, integrating some processes.

Knowledge has evolved into a key resource for a nation's military might, economic power, and other areas. Knowledge management is the act of generating, capturing, codifying, and transferring knowledge throughout an organization in order to gain a competitive advantage. [2]. In general, KM focuses on organizing and making available essential knowledge, wherever and whenever needed. KM is the intellectual capital. That is why we need to manage it properly.

B. Knowledge Management System

Knowledge management (KM) is defined as the act of creating, codifying, capturing, and sharing knowledge in order to gain a competitive advantage. A KMS supports KM in an organization. It integrates the latest technology and social/structural mechanisms [2].

To determine which KMS is the right one to apply, we must identify the KM solution. Measurement of organizational knowledge is needed using the contingency factor approach [9]. The three most used methodologies are SECI, Tiwana's KM roadmap, and Fernandez's methodology [3]. The components of knowledge conversion, Socialization, Externalization, Combination, and Internalization (SECI), can measure how far knowledge has been managed in the organization [10]

C. Project Management Body of Knowledge (PMBOK)

PMBOK is a PMI standardized project management framework. This framework instructs project managers on utilizing a methodical and well-defined approach to improve project success rates. With this guide, the project success rate can become higher, more reliable, and stable [11].

The previous PMBOK version used a conventional development approach such as the waterfall approach. Due to the agile approach offering flexibility and iterative development, agile became a common project development approach [12]. PMBOK 7 edition emphasizes the project performance domain. So that it can make this framework suitable for all development approach whether the project uses predictive, agile, adaptive, traditional, or hybrid development approaches. Team, stakeholder, planning, project work, development approach and life cycle, delivery, measurement, and uncertainty are the eight domains of project performance.

III. METHOD

The research was conducted into some steps based on the Kitchenham SLR method. In the first step, we begin to identify the need for SLR and review protocol at stage 'Planning.' We begin the research process by defining the objectives and key points. Objective and focus points are stated in the introduction section of this paper. After establishing the objectives, research questions, and scope of the study, we immediately begin the information retrieval process at the'search for publications' stage. We searched multiple relevant databases for scientific publications (papers and conference proceedings) such as Scopus, Science Direct, ACM Digital Library, and IEEE Xplorer. The following combined search string was used across all databases: ("KMS" OR "Knowledge Management System") AND ("Metodologi" OR "approach" OR "Framework") between 2016-2021 and only for paper and conference only.
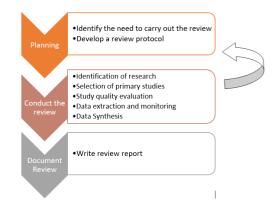

Fig. 2. Process model for systematic literature review

We compiled the findings and used a selection process that included factors. In the initial stage, we include some criteria such as English-language publications, the year between 2016-2021, and exclude articles that do not use English. In the first stage, we include search criteria such as titles and abstract containing some string that correlates with the goal of this paper and the appropriate content relevant to the work. We removed data that could skew the outcomes of our study, such as duplicate publications or articles that were not appropriate for our purposes. In the last stage, stage 2, We carefully searched the full paper that answered the research question and excluded papers that could not be accessed. Table 1 shows how the research stages were implemented.

The literature quality has been employed from the final papers before extracting the data. This step is needed to make sure that the paper has the quality to answer the objective of this paper. The extraction of data and synthesis results are stated in the result section.

IV. RESULT AND DISCUSSION

A. Publication

We found 5678 papers related to the query string. Papers were selected based on the criteria mentioned in the methodology section. Some papers couldn't be accessed, so we excluded that paper from this result. As a result, only papers that satisfied the requirements were picked.

TABLE I

SELECTED PAPERS BY THE STAGE

Source	Initial Stage	Stage1	Stage2
IEEE	4131	26	17
ACM Digital Library	1197	13	10
Scopus	348	6	3
Science Direct	2	1	1
Total	5678	46	31

As the results showed, the number of final papers found is 31. The years of publication for all the papers are between 2016 and 2021. The summary of final papers distribution according to the year they were published is shown in figure 2. As a result, we can see that the studies increased significantly in 2019. In 2021 there are few papers found, maybe because this paper write in the middle of the same year

Fig. 3. Overview of publications related to development KMS methodology or framework by publication year.

IEEE has the highest matched papers (17), which only have one piece, followed by ACM (10), Scopus (3), and only one paper on Science Direct. Table II contains the final papers as well as the library source.

TABLE II

SELECTED PAPERS BY THE LIBRARY SOURCE

Source	Final Paper	Papers
IEEE	17	[13] [14] [15] [16] [17] [18] [19] [20] [21] [22] [23] [24] [25] [26] [27] [28] [29]
ACM Digital Library	10	[30] [31] [32] [33] [34] [35] [36] [37] [38] [39]
Science Direct	1	[40]
Scopus	3	[41] [42] [7]

B. Development Approaches

Each organization has its unique challenges. The project manager must adapt their approaches to face these challenges to manage projects successfully. In terms of KMS development, some development approaches can be chosen. Predictive, agile, adaptive, classic, and hybrid development methodologies are available. Predictive, hybrid, and adaptive are three often employed methodologies [6]. When the needs can be established at the start of the project, the predictive approach can be beneficial. However, the adaptive approach can be helpful in the opposite circumstance. The adaptive and predictive methodologies are combined in the hybrid development approach.

The summary of the distribution of the final paper according to the development approach is shown in figure 3. We can see that most of the studies used the predictive approach (15 sources), studies that used adaptive only have two sources. The requirements, scope, schedule, and risk can be defined at the start of the project. We summarized the complete phases and comprehensive development process using this result and presented it based on the predictive approach.
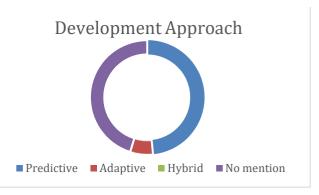

Fig. 4. Development approach used in the literature

C. Process, Model, Method, and Artifact in KMS Development Based on PMBOK

Many factors influence the type and amount of project stages in the project life cycle [6]. Each KMS development methodology has a unique phase and life cycle. We comprehensively simplify the phase and development process in the predictive approach based on PMBOK.

The project management process can be grouped into inputs, tools, and techniques, and output designed to meet organizational needs, stakeholders, and projects. Each step of the project life cycle interacts with Process Groups, although Process Groups is not the project phase. Processes in the Process Groups category do not follow any particular order. Depending on the project's requirements, the number of iterations and interactions across processes varies. The initiating, planning, executing, monitoring-controlling, and closing process groups are divided into PMBOK 6. Table 4.3 shows the results in greater detail. In the initiating process category, the processes are more intended for initial preparation to define new projects or new phases of existing projects. The major goal of this category is to obtain approval to begin a project or phase. The preparation of business cases and project approval are also included in this category. This process group determines whether a project is compatible with organizational goals and maybe implemented [6]

TABLE III
KMS DEVELOPMENT PROCESS BASEt ON PMBOK

Process	Source Papers	Freq	Models (Mo), Methods (Mt), and Artifacts (Ar)	Team	Stakeholders	Dev Approach and Life Cycle	Planning	Project Work	Delivery	Measurement	Uncertainty
						PMBOK 7.0 — Performance Domain					
Initiating Process Group											
Identify the need and scope of the project	[7] [13] [16] [18] [29] [30] [36] [37] [42]	9	Mt: Business justification analysis methods.				√			√	
			Mo: theory of needs	√			√	√			
			Ar: Scope Statement				√	√	√	√	
Analyze the existing Infrastructure & feasibility assessment	[7] [14] [16] [17] [18] [21] [33] [34] [36] [42]	10	Mt : APO KM Assesment				√		√	√	
			Mt: SWOT analysis				√				√
			Ar: feasibility study report				√	√			
Identification of organizational strategies, goals, objectives and aligning with KM	[7] [14] [16] [18] [19] [21] [23] [35] [36] [38]	10	Ar : Busines Case		√		√				
Identify stakeholder and Form KM Team	[7] [13] [16] [18] [21] [22] [34] [36] [38] [40]	10	Mo: Negotiation		√		√	√	√		
			Mt: Stakeholder analysis		√		√	√			
			Ar : Project team charter	√				√			
Problem analysis	[15] [20] [22] [24] [30] [33] [34] [35] [37] [42]	10	Mo: Rich picture diagram								
			Mt: Root cause analysis					√	√		
			Mt: Benchmark						√	√	
			Ar: Process Analysis document				√	√	√	√	
Identification of Contingency factor	[25] [26] [29] [42]	4	Mt : Contigency Factor Analysis								
Identification KM Process based on Contingency Factor	[25] [26] [42]	3	Mt: Contingency Factor Matrix								
Prioritization	[7] [17] [25] [26] [29] [30] [42]	7	Mt: Prioritization Schema		√			√			
			Ar: Prioritization matrix		√			√	√		
Identification Current KM Process	[16] [18] [19] [24] [25] [26][32] [35] [42]	9	Mt : KM Process Analysis								
Identification additional KM Process Needed	[25] [26] [30] [34] [42]	5	Mt: SWOT analysis				√				√
			Mt: Prioritization Schema		√			√			
The commitment of enterprise management	[7] [28]	2	Mo: Effectiveness of Communication channels	√	√		√	√			
			Ar: Stakeholder engagement plan		√		√				
Identification of decision criteria by which the various courses of action may be assessed	[7] [13] [19] [20] [22] [24] [28] [29] [35]	9	Mt: Alternatives analysis				√	√	√		√
			Mt: Make or buy Analysis				√	√			

			Mt: What-if Scenario Analysis			√			√
			Ar: Project Charter	√		√			
Planning Process Group									
Create work schedule	[7] [13] [15] [34]	4	Mt: Kanban board						
			Ar: Schedule management plan			√	√	√	
			Ar: Gantt Chart			√	√		√
Risk Assesment	[7] [13]	2	Ar : risk register			√	√	√	√
Develop a communication plan	[13]	1	Ar: Communication Management Plan	√		√	√		
Formulation Conceptual Model	[31] [42]	2	Ar: Flow Chart			√	√	√	
Knowledge Map	[7] [16] [23] [26] [31] [38] [40]	7							
Create knowledge Model	[27] [29] [33] [42]	4	Mt: Model Evaluation Method						
			Mt: CommonKADS						
Functional, technological, and graphic design	[7] [17] [19] [20] [23] [25] [26] [27] [30] [31] [33] [34] [35]	13	Ar : Use case			√		√	
			Ar: UML			√		√	
			Ar: Requirements documentation	√		√		√	√
Technology Mapping of KM Processes	[20] [29] [34] [35] [42]	5							
Design KM Infrastructure	[16] [18] [21] [24] [26] [29] [30] [40]	8							
Executing Process Group									
applying specific IT infrastructure and tools	[13] [15] [16] [18] [21] [22] [24] [26] [29] [34] [37] [38] [39]	13	Mt: Prototyping						
connect the explicit knowledge variables of organization with KMS	[7] [35] [36]	3							
Installation of the software in the server of the organizationanban	[7] [35]	2	Ar: new KMS						
Training of related user	[7] [24] [37]	3	Ar: user manual						
Monitoring and Controlling Process Group									
Monitoring and evaluation of the performance system	[7] [13] [15] [18] [21] [24] [37]	7	Ar: Status report				√		
			Ar: Milestone schedule		√	√	√		√
			Ar: Gantt chart			√	√		√
Interview/survey about user level of satisfaction	[7] [15] [16] [18] [19] [24] [25] [26] [27] [31]	10	Mt : Questionnaire / interview						
			Mo: The 8-step process for leading change	√		√	√		
Conduct analysis of the stability of the system	[7]	1	Ar: Quality report			√	√	√	
Provide recommendations, suggestions, and conclusions	[15] [18]	2	Ar: Project Review	√		√	√	√	
Questionnaires have been spread to know the benefits of the seven audit categories APO KM Assessment tools.	[19]	1	Mt: APO KM Assessment						
Create control tool (documentation, dashboard)	[13] [24]	2	Ar: changelog					√	√
Organize process review and Sustain	[13] [24]	2	Ar: process control plan			√	√	√	
Modify/adapt the system according to review	[7] [13] [16] [18] [31] [37]	6	Ar : change log					√	√

Closing Process Group											
Termination Conduct Post project review	[13]	1									
Close customer contract	[13]	1	Ar: project closure document								
Add Project Experience, Lesson learn, & best practice	[13]	1	Mt: Lesson Learned	√		√	√	√			
			Ar: Leason Learn Register				√				

Nine Paper started the project by determining the scope and needs of the project [7], [13], [16], [18], [29], [30], [36], [37], [42]. At this stage, the research focuses on how deep the project, coverage - project limits, and the estimated rough time the project can be completed [16]. We can use a scope statement document for summarising and restricting the boundary in the project. In the PMBOK performance domain, the scope statement refers to planning, project work, delivery, and measurement [6]. Before the executive permitted KMS development projects that could cost thousands or millions of dollars, the project must begin with the feasibility study [7]. The feasibility study discussed several questions. The question ensures that the project can be done, affordable, appropriate, and practical. The feasibility study includes the existing infrastructure assessment. This stage is carried out by ten papers in the methodology they use for KMS development [7], [14], [16], [17], [18], [21], [33], [34], [36], [42].

The other processes in this category are identification of organizational strategies, goals, objectives and aligning with KM process, identification of stakeholders and team formation, problem analysis, identification of contingency factor, KM process identification, prioritization, identification of current KM processes, identification of different KM processes needed, and commitment from management.

The procedures in this category are needed in the planning process group to determine the necessary activities to fulfill the project's goal. Process in this category include creating a work schedule, risk assessment, developing a communication plan, formulation conceptual model, knowledge map, creating knowledge model, functional-technological and graphic design, technology mapping of KM Process, and Design KM Infrastructure.

Some processes in the executing process group include applying specific IT infrastructure and tools, connecting the organization's explicit knowledge variables with KMS, installing the software in the organization's server, and training related users. From Monitoring and controlling, We found eight processes that can we choose. In the last closing process group, we found three processes. Only one paper includes this process in their methodology. This process complements other methodologies.

V. CONCLUSIONS

From this research, the predictive approach showed as a more widely used approach than the adaptive and hybrid approach. We have answered the research gap in previous research. As a result, We found 36 processes in the developing KMS based on the PMBOK. We translated the development process into a model, technique, and artifact. We presented it by group process to help the organization develop a KMS project to improve effectiveness and improve its competitiveness.

We have presented a comprehensive process in KMS development. But every project has its uniqueness. "One Size does not fit all"; each project requires a different approach depending on many variables. PMBOK version 7 focuses on the tailoring process. Even though we have presented a list of processes for developing KMS, projects still need tailoring so academics can choose the steps by the project's needs. Therefore, developing a methodology devoted explicitly to these fields is necessary according to existing project management rules. Then it needs to be detailed more about the methods, models, and artifacts used in each process.

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