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ABSTRACT

Due to rapid changes in software applications, especially incorporating the demands of self-regulating technologies becomes a major challenge in software projects. This research focuses on technological, managerial, and procedural challenges, which are believed to be the most significant factors contributing to projects failure. To address these issues, this study proposes Monolithic Ontological Methodology (MOM) which addresses the weakness in the existing benchmark methodologies including PRINCE2, Extreme Programming, and Scrum in terms of project management, quality control, and stakeholder involvement. The MOM consists of seven phases and each phase has the required number of iterations until it is approved by management. The updated information is recorded and shared with the respective teams. The standard documentation with control language is structured by descriptive logic (DL) that reduces ambiguity and technical debate. Furthermore, the illustration of the MOM includes figures, logical expressions, and descriptions. To demonstrate the effectiveness of the proposed methodology, an Analytic Hierarchy Process (AHP) was performed. The findings indicate the validity of MOM concerning considered performance metrics. Although the applicability of the proposed methodology involves relatively more documentation and formalities. The adaptive nature of MOM makes it suitable for the standard organization and brings sustainability to the organization by implementing distributed project management.

Keywords: Software project management; Software quality control; Methodology; Sustainability; Ontology.

INTRODUCTION

According to the Standish Group Report (S. Hastie, & S. Wojewoda, 2015), every year a significant number of IT projects fail partially or completely for reasons related to people, task, process, and/or environment (Timo O et al, 2014); there is no single reason to point out for project failure (N. Cerpa & J. M. Verner, 2009) as there has been a causal relationship among the above-mentioned reasons. The successful delivery of a project depends on the understanding of tasks and adopting an appropriate process that maps the skills, experience, and relationship of team members. Incorrect or inefficient resource allocation is one of the key causes of project failure (Al-Ahmad W. et al., 2009). Some research studies emphasize the understanding of requirements, realistic plan, appropriate methodology, accurate design, the effectiveness of implementation, adequate testing, and correct resource allocation (time, cost, technicalities, and human). This may contribute to a successful project. Noor Habibah Arshad et al.,2007 suggested the organizational structure and policy, whereas McLeod et al.,2011, argued that knowledge of the business domain and motivation of the team contribute to a successful project. It is essential to perform risk management (Haneen Hijazi et al., 2014), change management, and resolve technical debates by management. Most of the methodologies describe a workflow, phases, processes, and internal sequence with one or more iterations. The success rate of a project primarily depends on the performance of the management team. Moreover, the management team should enhance sustainability by reusing design and code, effectively employ internal tools, and implement in-house environmental sustainability practices. There are plenty of methodologies and selection of a methodology is difficult due to the criteria: size, risk, stakeholders' demand, and complexity of the project. "Each methodology is unique" and "each project is unique," so appropriate methodology selection is a complex work too. Though the best practice is continuing in the software firms, till now more than 20% can not be completed and around 50% of the project delivered without user satisfaction (S. Hastie, & S. Wojewoda, 2015), and this research has proposed MOM to ensure effective project management approach that can improve quality of the product too.

LITERATURE REVIEW

An ontology relates to the existence, reality, and the categories of being and their relationship (Gruber T., 1995). The philosophical ontology was introduced in computer science (Gruber T., 1995) to specify features of domain knowledge and information sharing (Neches R. et al., 1991). Sooner it was adopted by computer scientists in the application area of artificial intelligence (Guarino N., 1998). It became popular in the fields of knowledge management systems (Lai L.F., 2007) and a vast amount of ontological applications is found in web science, that is, semantic web and e-commerce (Fensel Dieter, 2004). Standard research platform creation is one of the important contributions of ontology. The use of ontological approach improved research on genome data format specification (Ashburner M. et al., 2000), vocabulary specification for agricultural information (Clément Jonquet et al., 2018), and data standardization in health informatics (Sunitha A. & Suresh B. G., 2014; David Riaño et al., 2012). The semantic web (Gómez-Pérez A. & Corcho O, 2002) is an active research area and popular for the use of ontology in computer science which provides a basis for the semantic web. It also applied for information specification, clustering, and object-oriented structuring, or class hierarchy development. There is a wider acceptance of this approach in computer science, and therefore, W3C (Heiyanthuduwage S.R. et al., 2016) standardized the ontology in the semantic web. Information visualization ontology gathers information from multiple sources to display in a single unit (Fluit C. et al., 2006). Ontology is used for requirement specification (Kamal Uddin Sarker et al., 2017) and quality factors specification (K. U. Sarker et al., 2018) by descriptive logics in software project management. It emphasizes sustainability practice (Kamal Uddin Sarker et al., 2018) into an IT project by improving the quality of the process and product, reducing execution time and cost (V.K. Chawlaa et al., 2018). Practicing project management is being momentous with explicit specified information of ontology. Recent studies have shown that ontology modeling could be effective for smart application (K. U. Sarker et al., 2019) and big data management (Sarker Kamal Uddin et al., 2019).

A typical methodology is a collection of sequential and simultaneous actions. The methodology selection depends on user requirements, project size, degree of risk, and nature of the project. While some methodologies are good for high-risk projects but not appropriate for small projects. The waterfall model is a standard one among plan-driven approaches, which is the foundation of many methodologies today. However, it overlooks risk management. Similarly, XP is an agile approach, which is appropriate for small or medium-sized projects (K. Schwalbe, 2009).

Rapid Application Development (RAD) is an incremental model, which is considered appropriate for low-risk projects (R. S. Pressman, 2005). Scrum is a popular agile method for large object-oriented projects, while the Spiral model is good for high risk and large projects (K. Schwalbe, 2009; R. S. Pressman, 2005). Agile methodologies are flexible towards requirements changes and focused on customer satisfaction and teamwork (L. Williams, 2010). However, Scrum and XP lack documentation practice, unstructured managerial functions, and no support for distributed projects (Faiza Anwer et al., 2017). Moreover, agile does not consist of the functionalities of a virtual project management approach. PRINCE2 supports a virtual project management approach that is popular in the UK and currently used in more than 50 countries (Radka Vaníčková, 2017). But it takes longer decision-making time and less or no importance is given to human management. It does not fully support the change management process and output prediction before completion. Distributed project management allows working from any corner of the world in a software project that is economical for software industries and scope for experts. But existed methodologies are not enough to manage distributed project management.

RESEARCH METHODOLOGY

The research has proposed a methodology that is elaborated with diagrams, ontology, and DL in the section below. It is comparatively massive in size and decomposed into multiple lattice forms as well as an explicit presentation with DL. It is called "monolithic" due to the explicit specification of the project information (Kamal Uddin Sarker et al., 2020a) that is presented by a rigid structure of the methodology. The concept of ontology is used to present project information in a formal structure that can improve sustainability by reusing, sharing, and re-constructing (Kamal Uddin Sarker et al., 2020b). MOM aims to address current issues relating to the managerial process, documentation, sustainability, and way of control. The monolithic methodology is decomposed into seven lattice ontologies and each lattice ontology reflects the respective phase that is demonstrated by diagrams, logical expressions, and explanations. MOM is proposed to allow the virtual management system to improve business goals. Gray Rational Analysis (GRA) and Analytical Hierarchy Process (AHP) are the two most popular methods in Multi-criteria Decision Making (MDCM), where GRA is used for group comparison, while AHP is used for pair comparison (Sarker KU et al., 2020). The process of analysis includes pair comparison in five factors: involvement of management, standard documentation, sharing environment, engagement of stakeholders, and consideration of software quality factors. The analysis process is synchronized with reciprocal matrix, normalized matrix, and priority values based on the average score of the expert. A better score is found for MOM than XP, scrum, and PRINCE2 that is visualized in a graph. The work is concluded with future work that recommends the importance of a virtual ontology.

MONOLITHIC ONTOLOGICAL METHODOLOGY (MOM)

MOM (Figure 1) consists of seven sequential steps, and each one is directly controlled by management. It will allow the required number of management interactions within a task in any phase. The management team will be formed with a hierarchy and they are directly connected to a phase for providing instant feedback. For additional feedback, management is responsible to communicate with respective stakeholders. Updated information will be recorded and shared with respective phases and stakeholders. This practice will provide standard documentation and formal management. Each inclusive lattice ontology is decomposed from the monolithic (Figure 1) with the role of stakeholders.

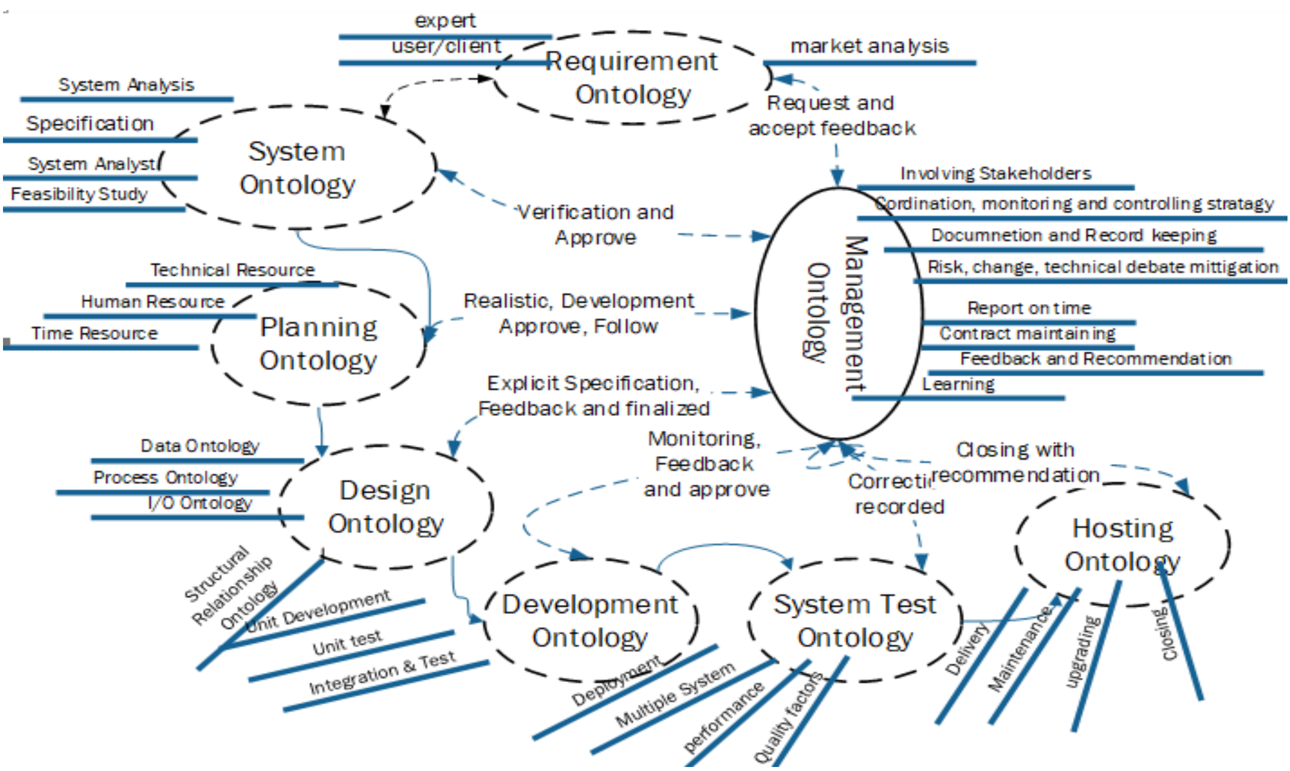

Figure 1. Monolithic Ontological Methodology (MOM); dash lines indicate flexibility in the scope of the phases based on the project's nature, while solid lines indicate the fixed functionalities of the stage.

Each phase has an individual set of definitions and actions that are specified with descriptive logic. Well-defined definitions (specific and ambiguity-free) and actions are used to generate rules, that is, ontology presented by DL. An overview of each phase is represented by a diagram, called lattice ontology. The output of one activity is used as an input of the subsequent phase(s). So, standard documentation can reduce the complexity of information sharing. MOM ensures standard records in all phases to improve reusability and maintainability. This methodology may be effective in an online distributed continent development project. The working principle of the proposed methodology is synopsized by the following algorithm:

Algorithm:

- Start
- Develop organizational standard document, format, policy, and convention
- Include the required phases from the MOM according to the size of the project
- Allocate resources: human, time, hardware and software
- Apply MOM as follows:

  For phase 1 to n

  Repeat until: Submission_of_team$_i$ is not approved by management and keep a record of each update

  If Submission_of_team$_i$ is approved by management

Then, Submit to $team_i+1$ and recorded by $team_i$, $team_i+1$ and management

End if

End for

- End

Lattice Requirement Ontology

Primary Software Requirements Specification (SRC) is an action that collects functional requirements. The requirements engineers bring completeness by functional and non-functional requirements specification. The quality requirements are emerged by expertise while market analysts show up on additional features for the system. Management approves the requirements according to the business goal of the organization. The integrated requirements are $R \equiv UR_i \cup MD_i \cup ER_i$, where R is the set of requirements, $UR_i \subseteq$ is user requirements, $MD_i \subseteq$ is market demand requirements, and $ER_i \subseteq$ is expert-recommended requirements. The optimization technique is applicable to remove redundant requirements during the integration process. Also, conflicts appear on requirements represented by a high-quality graphical display that opposes sustainability demand. And it can be formularized by $UR_i \equiv (MD_i)^{\sim} \vee UR_i \equiv (ER_i)^{\sim} \vee MD_i \equiv (ER_i)^{\sim}$. The understanding of quality factors, security, integrity, validity, elicitation, and changes, is new challenge in this phase (Tejas Shah & S. V. Patel, 2014). MOM facilitates the required numbers of iterations with management to assure the quality by reviewing and overseeing. DL is used for specification to reduce misunderstanding among the stakeholders by standard documentation. It will assist in a distance mode working environment. Figure 2 simply digests the requirement finalization process.

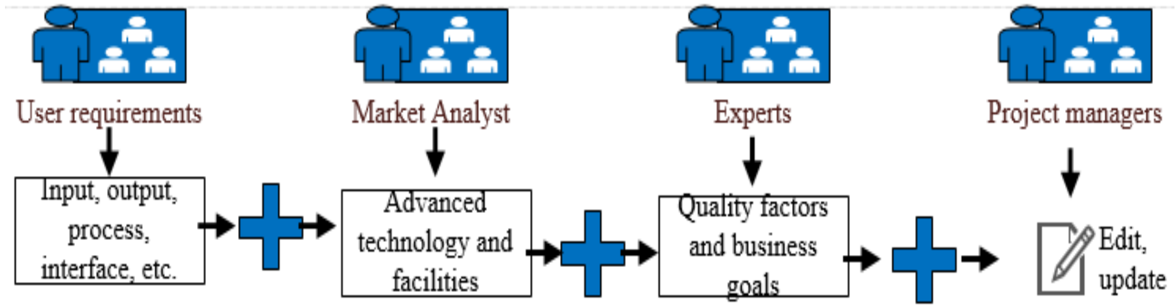

Figure 2. Lattice Requirement Ontology.

Lattice System Specification Ontology

When developing a system, the Business Functions (BF) of an organization are converted to Software Functions (SFs). The systems analysts design a solution that includes all BFs. The BFs and SFs relationship is, *Decompose*(BF)={BF_1, BF_2, BF_3 BF_4……… BF_n} →Mapping($BF_{1,\ldots\ldots,n}$, $SF_{1,\ldots\ldots,n}$), where $SF_i = \sum U_p + BF_{j=0,1,2,\ldots,n}$. And a software process may be unique one (U_p) or with one or more BF so functional dependency can be represented by $SF_i \rightarrow BF_j$. The simplification technique is applied to remove redundant or unnecessary processes by multi-criteria decision-making approach for deducting complexity. The process selection depends on technology, requirements, budget, and business goals of the organization. These are internally dependent on each other and directly align with the objectives of the company. An effective feasibility study (Figure 3) proposes a package with a better combination of minimized risk, optimal throughput, and maximize business profit. A feasibility study includes analysis on technical, economic, social, time, and human aspects. Individual measures are summarized to assess the capacity of the organization. A cumulative collection of individual measures of a software project generates the final output of a feasibility study based on the following formula:

$$(OutCome)^{Feasibility} = \sum_{k=0}^{n} \text{Feasibility(Resource)},$$

where resource={technical, human, cost, time, ethical, etc.}. The study helps to reduce the risks of the project iteration. Actions, processes, or quality factors are modernized by management with strategic level thought in the feasibility, aimed to maximize profit and minimize risk. This feedback is important because 64% of organizations faced misunderstanding of the business process and 44% of the projects underpinned by missing acceptance, while 28% claimed a lack of support from management (Pouya A K et al., 2018). Hence, MOM introduced formal communication and standard documentation to minimize technical debate.

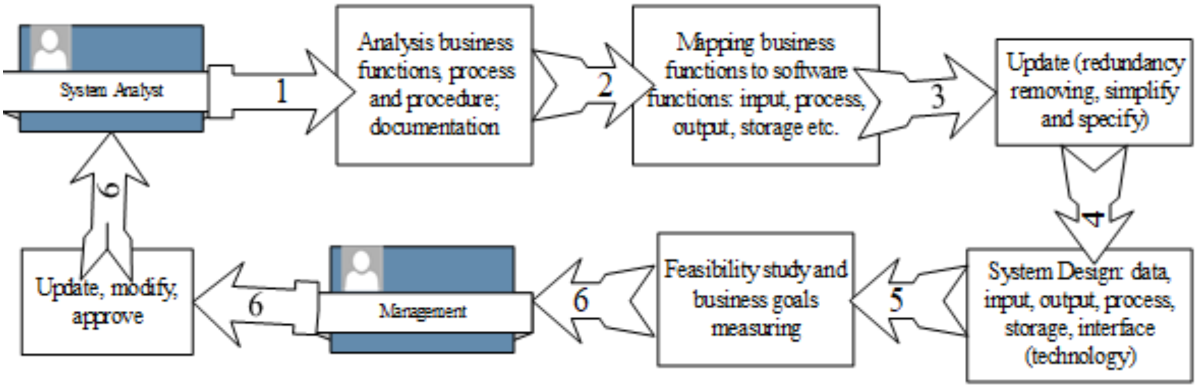

Figure 3. Lattice system specification ontology.

Lattice Planning Ontology

Software Quality Control (SQC) depends on Software Planning (SP) and Software Quality Assurance (SQA). According to SQA guideline, and methods, a realistic SP development and practice can improve the project success rate. The modeling function of SQC can be F(SQC)=F(SP, SQA), where F(SP)=F(task, time, resources) and F(SQA)=F(Method, guidelines, standardization, etc.). The managerial plan consists of human resource allocation at an appropriate position based on skills and availability; skill development training hosting; proper utilization of technical resources; effective time management; and developing and practicing acceptance policy and monitoring strategy. When the plan is realistic and complete, the execution phase of a project can run smoothly. Critical observation on the project includes tracking, monitoring, controlling, and keeping documentation of all events (Figure 4). The ontological monitoring plan records clear-cut and real information which may help in supplementary action like critical performance evaluation of a process. For bottom-up planning, this information is reused in a similar type of upcoming project. A realistic plan with a standard record of sufficient information minimizes the risk of a project. MOM's automatic alert system shares updated information with respective stakeholders. Moreover, resource allocation becomes more critical in a multi-project environment (Amol Singh., 2014), and MOM mitigates the challenges by attaining maximum utilization of resources.

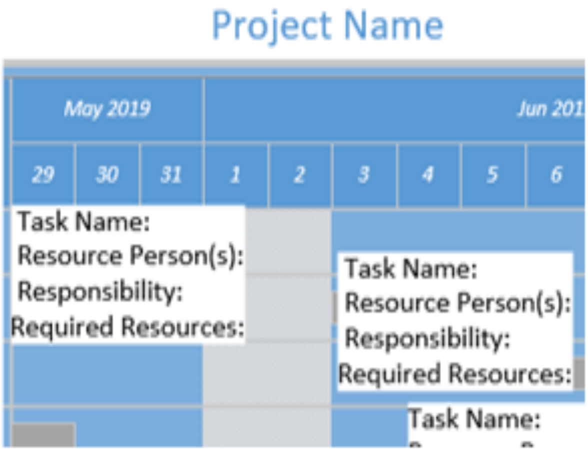

Figure 4. Lattice planning ontology.

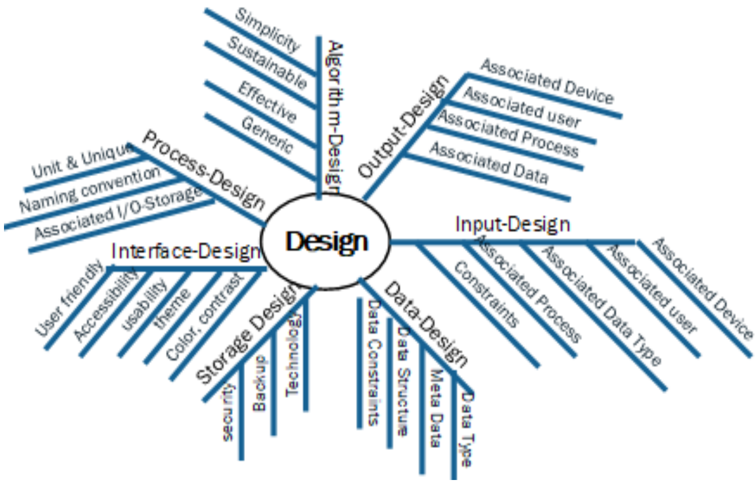

Figure 5. Lattice design ontology.

Lattice Design Ontology

The design phase comprises software architecture with requirements (Figure 5) that were founded on technology. It can be represented as F(infrastructure)=F((hardware, software, database)→ technology). It suggests the setup of hardware, software, and database. This is one of the most important activities in this phase. An in-depth design includes requirements and their internal and external relationships. For example, an input form influences quality factors of an interface, constraints of the database, and characteristics of the technology. The context diagram is used to visualize the system, the data flow diagram displays relationships with actors, processes, and data files, the entity-relationship diagram shows internal relationships of a database, the use case diagram presents users' rules, system flow, and class diagram shows objects' relationship and object-oriented concepts. The aforementioned tools are the members of the tool-set of ontology and are used to specify the information of a system. But MOM gives more importance to DL because it can be an alternative of all by control language, structural context, and predicate logic. Semantic presentation is more flexible and logical to modify and share information in a virtual management system than diagrams. The design phase is decomposed according to the findings of the system specification phase that overcomes the transition challenges (Giuliano Casale et al., 2016). It brings a transition from the application development approach to application composition. It also minimizes ontological challenges (Giuliano Casale et al., 2016) because of its critical reviewing and documentation practice in all phases by management who are experienced.

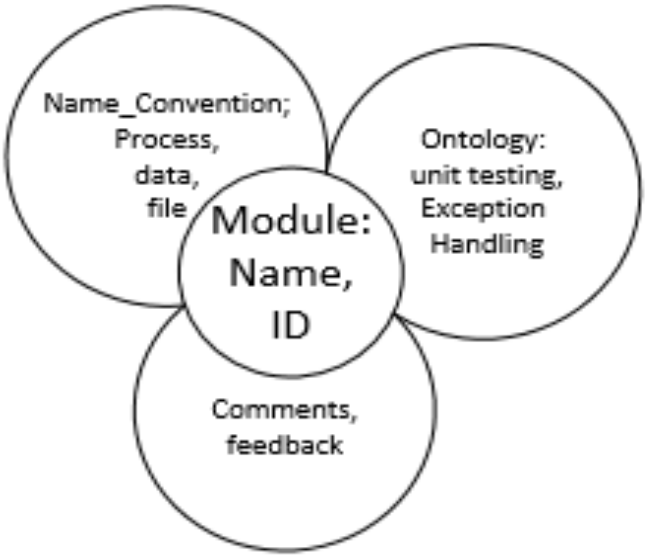

Figure 6. Lattice code ontology.

Lattice Development Ontology

Any shortcomings of the previous phases create more challenges in the coding phase (Giuliano Casale et al., 2016). The MOM provides standard documentation with logical relationships to reduce the risk of this phase. It also ensures coding documentation with a sufficient scope of modification (Figure 6). Besides, it reduces the challenges including ambiguity, technical debate, and repeating activities (Giuliano Casale et al., 2016) that are common in the conventional coding phase. The MOM module is a unit of an application that is defined by naming convention for file, process, data, and comments. This normalizing meta-data assures the reusability of information and change control and it makes the project maintainable (Figure 6). A module consists of a testing template and exception handling ontology in the coding phase. The implementation of logbooks to keep performance records in the unit testing process (Figure 7) improves the documentation system and quality of the product. A cluster is developed with a set of interrelated modules and it is evaluated by the cluster testing template. The integrated clusters are the system that is analyzed by system testing. System testing is performed by real users and domain experts before deployment for operation. Module and cluster testing are introduced by MOM, so that system testing becomes more efficient and decreases backtracking activities. Less number of claims in the maintenance stage will improve user satisfaction too. Moreover, an exclusive user manual will also improve user performance.

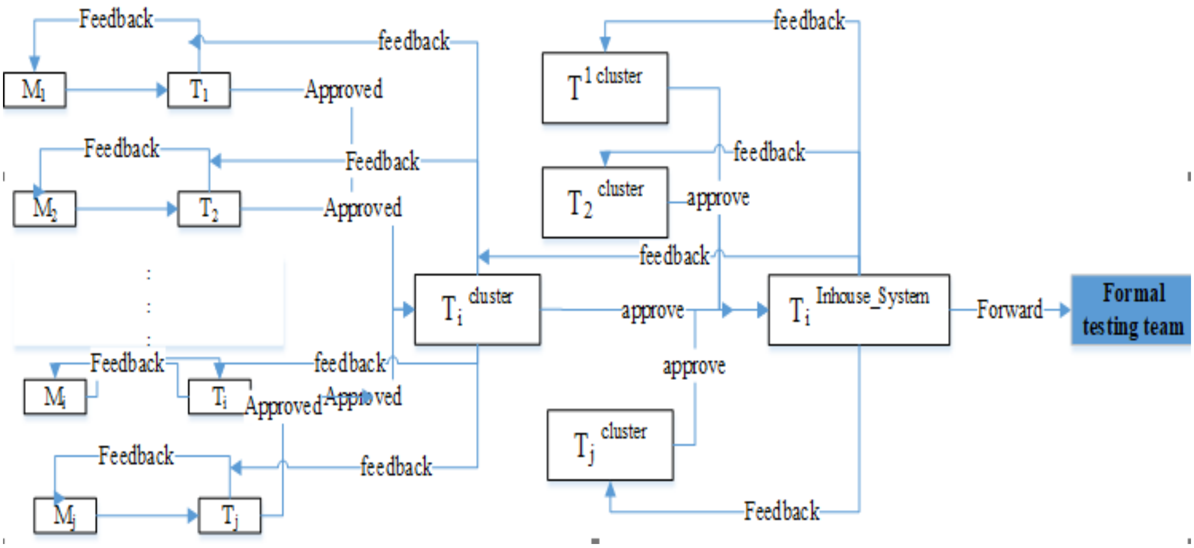

Figure 7. Lattice testing ontology.

Testing evaluates the completeness of functionalities and incorporates quality factors. Accuracy is acceptable when the required output(Yi) is found for exact input(Xi) according to requirements and it is denoted by (Expected output(Y(ti)) ≡ exact output(Y(ti)))← ((Expected input(X(ti)) ≡ exact input(X(ti))). Efficiency is the effectiveness of an action, response, and notification that is a function of time. For example, if the required time(Ti) is the minimum time to get output(Yi) for input(Xi) by the process(Pi), then it is an efficient process. In a multimedia application, quality is an optimal output that is accepted based on multiple parameters. For example, video_conferencing_quality ={synchronization, response_time, audio_signal, video_signal}. Maximum throughput is only expected when an efficient algorithm is implemented with effective technology. A secure transaction system, information sharing, and communication enhance reliability. In addition, information privacy, threat monitoring and protection, user authentication, and privilege are also the parameters of reliability. It consists of policies and procedures for in-house information access, control, and monitoring. Portability defines the scope of a system to adapt to future upgrade versions and variations in platforms. Generalization in design and development enhances the portability in MOM. DL does not depend on technology or computer programming. It is flexible to be implemented for clients and closing of the project with the user manual and managerial document:

- **maintenance:** a set of services to the client under certain conditions for a duration of time. The mode of communication and service price should be clearly defined.
- **upgrade:** enhancing the system under a mutual agreement to fulfill near future stipulations of users.
- **closing:** ending of a contract according to acceptance policy and property right of source code.
- **hosting:** system submitted for operation and starting access by utilization that consists of few activities mentioned before.

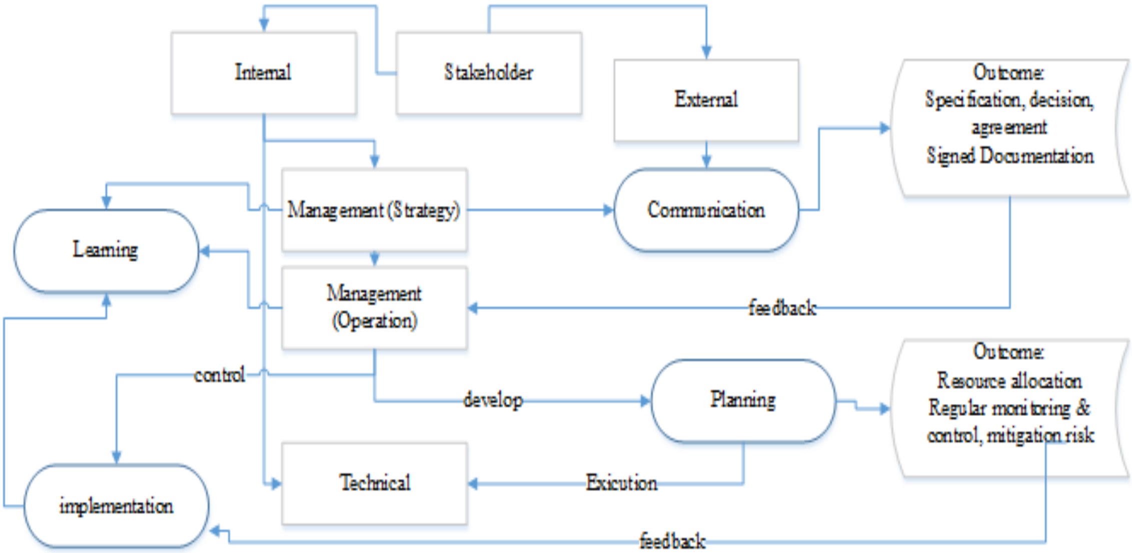

Figure 8. Lattice management ontology.

Lattice Management Ontology

The aim of this research is to bring all the activities of a project under MOM, which is a unique manageable process. All MOM phases are directly connected with the management team for tracking, monitoring, and controlling effectively. It reduces decision-making time in any phase. A common data-sharing platform is upgraded with the latest decision. So, concerned stakeholders are aware of any change, and standard documentation reduces ambiguity. The activity mesh of management is reflected in Figure 8. It is a comprehensive diagram that shows processes, methods, strategies, and stakeholders' communication. Management is responsible to implement a project and taking necessary actions to make success. Moreover, MOM improves the responsiveness of the stakeholders and emphasis learning from the project. The management team is leading the project and responsible to resolve technical debates, conflicts of interest and risks.

MODEL ANALYSIS

MOM phases are highly influenced by management because this is the key team in a project. A hardworking and well-trained management team can achieve project and therefore business goals. MOM is developed for average-size projects that aime to ensure the quality of product and process. A group of skilled team members handles different types of software projects in a multi-project environment. There are plenty of influential factors for software project management (Linåker J. & Regnell B., 2017; Luigi Lavazza et al., 2016; Edson Oliveira et al., 2018) and carry different values according to the nature of a software product. A set of common influential factors is selected to perform a comparative study based on the management of the quality of the process, product, and resources in Table 1.

Table 1. Selected influential factors of a project.

Features	**Extreme programming (xp)**	**Scrum**	**PRINCE2**	**MOM**
Development approach	Iterative and incremental	Iterative and incremental	Incremental / shared	Plan-driven with single-phase iterative
Stakeholders' participation	Throughout the process	Not defined	Formal	Throughout the process but more formal
Project/process management	Not defined	Practice available	No focusing on people management	Highly involvement
Documentation	Less	Less	Documentation oriented	More and formal throughout the process
Development order defined by	User/client or customer	Scrum team	Management	Project management team
Acceptance criteria	Defined	Defined	Defined	Step by step generated
Testing	Acceptance/unit/integration	Not mentioned	Defined	Unit testing by unit developer, integration, andsystem by the required persons
Adaptability	Focusing on object-oriented	Focusing on object-oriented	Can be adapted to any project	Can be adapted to any project
Product quality	Not mentioned	No clear project definition	Focusing	Focusing
Change control	Not mentioned	Frequently change	Partial	Well-structured management
Working environment	Face to face collaborative	Not clear	Shared	Distance environment

Even though the generalization comparison includes so many influential factors in Table 1,AHP includes only the most important five factors (Table 2). So, it is evaluated by an expert who has more than 15 years of experience in the software industries. The methodologies are compared with Stakeholders' Involvements, Management's

Activeness, Shared Environment, Formal Documentation, and Focusing on Quality of Product. The comparison comprehends XP, PRINCE2, and Scrum with MOM because those have a better influence on the selected comparative factors. with the MOM. For AHP, the paired comparison is mapped in Table 2 by the expert during January 2020. Four methodologies create a 4×4 reciprocal matrix for each factor from Table 5.1 and according to the following algorithm.

Algorithm: Analytic Hierarchy Process (AHP)

Start

1. **Generating a reciprocal matrix:**
- SET 1 for the common field of the same methodology and it will cover one diagonal.
- Insert actual judgment to the left/right of 1s' (left side here: 9,7,5,3,)
- Insert reciprocal value to another side (Aij=1/Aji) (right side here:1/9,1/7,1/5,1/3)

2. **Generating Normalized matrix**
- Normalized matrix: Divide each element by the sum of the elements of that column

3. **Priority Value:**
- the sum of all row values
- A high value means better

End

A reciprocal matrix is generated for each analogy factor of Table 2 and chronologically mentioned in the left-most column of Table 3. It has the respectively normalized form of matrix beside and followed by priority values. The priority values are the actual cumulative values,and this is visualized by Figure 9. MOM is better than any other in the area of management-involvement, documentation, and integration of quality factors. It achieves a higher rank in the consideration of "stakeholder engagement" and "sharing the working environment" with PRICE2. Hence, it is better for standard organizations.

Table 2. Pair comparison.

Pair comparison scale (odd numbers from 1 to 9): extreme favors(EF)=9, very strong favors(VSF)=7, strongly favors (SF)=5, slightly favors(SlF)=3, and equal (E)=1											
Factors	**Methodology**	**EF**	**VSF**	**SF**	**SLF**	**E**	**SLF**	**SF**	**VSF**	**EF**	**Methodology**
Focusing on effectiveness of management	MOM			√							PRINC
	MOM				√						Scrum
	MOM	√									XP
	PRINC				√						Scrum
	PRINC		√								XP
	Scrum	√									XP

Focusing on effectiveness of documentation	MOM				√						PRINCE2
	MOM		√								Scrum
	MOM		√								XP
	PRINCE2			√							Scrum
	PRINCE2			√							XP
	Scrum					√					XP
Focusing on effectiveness of sharing environment	MOM					√					PRINCE2
	MOM		√								Scrum
	MOM	√									XP
	PRINCE2	√									Scrum
	PRINCE2		√								XP
	Scrum					√					XP
Focusing on effectiveness of stakeholders	MOM					√					PRINCE2
	MOM				√						Scrum
	MOM			√							XP
	PRINCE2				√						Scrum
	PRINCE2			√							XP
	Scrum					√					XP
Focusing on quality of the product	MOM				√						PRINCE2
	MOM			√							Scrum
	MOM		√								XP
	PRINCE2				√						Scrum
	PRINCE2		√								XP
	Scrum						√				XP

Table 3. Comparison (reciprocal matrix, normalized matrix, and priority value) with AHP.

Reciprocal matrix					Normalized form					Priority	
	MOM	PRINCE2	SCRUM	XP		MOM	PRINCE2	SCRUM	XP		
MOM	1	5	3	9	MOM	0.6081081	0.7720588	0.421875	0.3461538	MOM	0.5370489
PRINCE2	0.2	1	3	7	PRINCE2	0.1216216	0.1544118	0.421875	0.2692308	PRINCE2	0.2417848
SCRUM	0.3333	0.3333333	1	9	SCRUM	0.2027027	0.0514706	0.140625	0.3461538	SCRUM	0.185238
XP	0.1111	0.1428571	0.1111	1	XP	0.0675676	0.0220588	0.015625	0.0384615	XP	0.0359282
	MOM	PRINCE2	SCRUM	XP		MOM	PRINCE2	SCRUM	XP		
MOM	1	3	7	7	MOM	0.6176471	0.6818182	0.5	0.5	MOM	0.5748663
PRINCE2	0.3333	1	5	5	PRINCE2	0.2058824	0.2272727	0.3571429	0.357142	PRINCE2	0.2868602
SCRUM	0.1429	0.2	1	1	SCRUM	0.0882353	0.0454545	0.0714286	0.071428	SCRUM	0.0691367
XP	0.1429	0.2	1	1	XP	0.0882353	0.0454545	0.0714286	0.071428	XP	0.0691367
	MOM	PRINCE2	SCRUM	XP		MOM	PRINCE2	SCRUM	XP		
MOM	1	3	7	7	MOM	0.6176471	0.6818182	0.5	0.5	MOM	0.5748663
PRINCE2	0.3333	1	5	5	PRINCE2	0.2058824	0.2272727	0.3571429	0.35714	PRINCE2	0.2868602
SCRUM	0.1429	0.2	1	1	SCRUM	0.0882353	0.0454545	0.0714286	0.07142	SCRUM	0.0691367
XP	0.1429	0.2	1	1	XP	0.0882353	0.0454545	0.0714286	0.07142	XP	0.0691367
	MOM	PRINCE2	SCRUM	XP		MOM	PRINCE2	SCRUM	XP		
MOM	1	1	3	5	MOM	0.3947368	0.3947368	0.375	0.41666	MOM	0.3952851
PRINCE2	1	1	3	5	PRINCE2	0.3947368	0.3947368	0.375	0.41666	PRINCE2	0.3952851
SCRUM	0.3333	0.3333333	1	1	SCRUM	0.1315789	0.1315789	0.125	0.08333	SCRUM	0.1178728
XP	0.2	0.2	1	1	XP	0.0789474	0.0789474	0.125	0.08333	XP	0.091557
	MOM	PRINCE2	SCRUM	XP		MOM	PRINCE2	SCRUM	XP		
MOM	1	3	5	7	MOM	0.5965909	0.6702128	0.4166667	0.45652	MOM	0.534998
PRINCE2	0.3333	1	3	7	PRINCE2	0.1988636	0.2234043	0.25	0.45652	PRINCE2	0.2821974
SCRUM	0.2	0.3333333	1	0.333	SCRUM	0.1193182	0.0744681	0.0833333	0.02173	SCRUM	0.0747147
XP	0.1429	0.1428571	3	1	XP	0.0852273	0.0319149	0.25	0.06521	XP	0.1080899

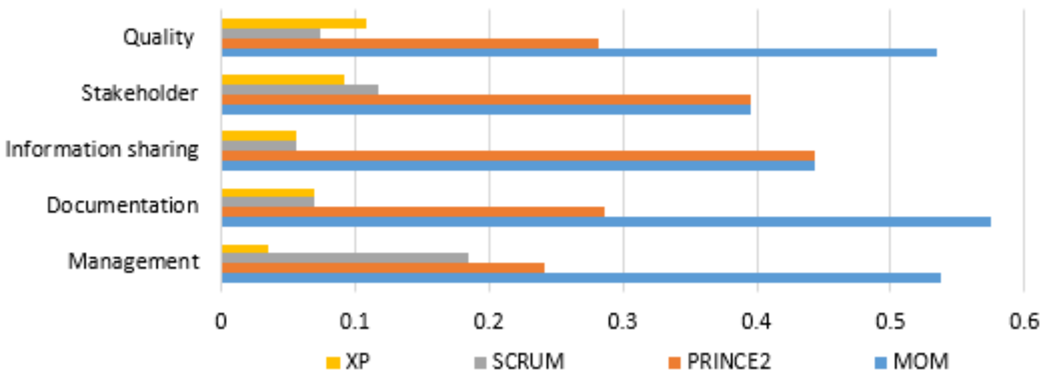

Figure 9. Result analysis.

CONCLUSION

This study proposed an explicit specification methodology that adaptively selects resources of a project from the organization. The MOM is a formal methodology that minimizes the challenges of a project by increasing more managerial interaction in all phases. MOM's explicit documentation that is standardized by DL reduces ambiguity and technical debate. An open-source market of software development and research field can enhance their capability by practicing MOM. This should support an online project management system. Its processes keep the record of all changes, data transfer, and process management actions. It will enhance the reusability and maintainability of the system. Moreover, DL information is applicable to process by an application and knowledge extraction. The system management process of MOM accelerates employees' interaction to improve performance. Stakeholders become responsive because of MOM's clarified working functions. The working load will be measurable and well-defined for each. MOM can easily adjust future enhancements if needed. It will ensure the quality of a product because of multiple reviewing systems and reduce project failure rates. It is mainly recommended for a standard software development organization. In a similar type of project, existing information (design, code) can be easily reused. But, MOM in individual problem solving will face overwhelming because of the in-depth specification and explicit documentation.Once an automated MOM system is drawn up in an organization, their work becomes easier for furthermore projects. It will diminish the feasibility study and execution time for imminent projects and that helps to make an early decision in the project initiation phase. Furthers works might combine more virtual project management features with artificial intelligence approaches to improve the quality of management.

Limitation and Future Work

This research performs comparison only; major factors and future studies may also consider more factors for AHP comparison. Moreover, the research could be evaluated by alternative multi-criteria decision-making tools. It is evaluated by a single expert but could be compared from multiple experts. Also, after implementing into the software industry, we can get the real reflection. The findings in this article point to the need to track 7 phases, but further study may focus on the control of managerial activities.

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