International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-04, Issue-10, Jan 2019

Knowledge Based Model Driven Workflow Pattern Approach for Composition of Business Process Web Services

Dr. J. Ghayathri, Associate Professor, Department of Computer Science (PG), Kongu Arts and Science College, Erode

Dr. S. Paneerselvam, Head & Associate Professor, Department of Computer Science, Erode Arts and Science College, Erode

Abstract: To accomplish a business process it is transformed in the form of web service in the web based world. For the automated business process communication more than one web services are used. This resultant process can be attained through the composition of web services. In this research work a model driven approach is followed to develop a graphical model using BPMN. The web services are categorized and selected based on QoS attributes and constraint based ranking. The developed model is executed through BPE and an enhanced Workflow algorithm is proposed to integrate all the segments to get an efficient optimized composite web service. A comparative analysis of proposed model with the existing composition models has been performed.

Keyword: BPEL, BPMN, Business Process, Knowledge Management, QoS, Web service, Workflow Pattern

I. INTRODUCTION

In general, Information Technology consists of three basic parts: computational data processing, decision support, and business software. [1]. Now it is extended with Content management, e-business solutions, quality testing and business intelligence. Focusing on communication technology, after mainframe technology; the client server technology along with personal computers and file servers had emerged. The autonomous and remote networking leveraged the development of distributed computing. When distributed computing elevated its role in the World Wide Web and internet the COM technologies and web services have placed a reckoned position in its own orbit.

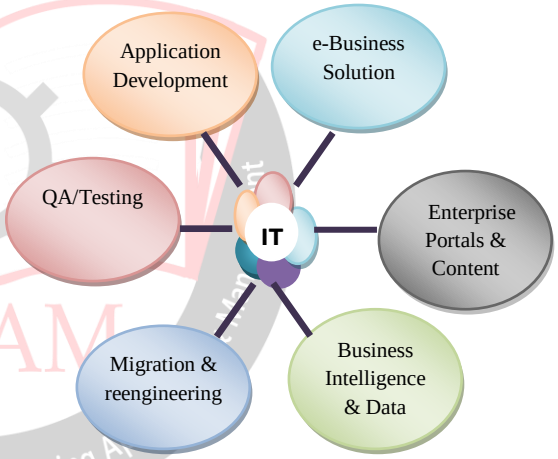

Fig 1.Applications of Information Technology

A. Knowledge management & decision support system

Knowledge Management (KM) focuses on four core processes such as innovation, sharing, retention and reuse of knowledge. The technologies associated with the KM are Cognitive Science, Expert systems, Artificial Intelligence and Knowledge base Management system, Electronic publishing technology and Hypertext, Decision Support System, Database technologies, Help-desk technologies, Brain storming applications, Performance support systems, Simulation software Document management, web managing tools etc. [2]. The Knowledge management can be categorized into two tracks such as the first track is Management of Information where knowledge means objects and the second track is Management of People in which knowledge consists of processes, a set of dynamic skills etc. Basically when information technology intelligence is incorporated into knowledge management it will become knowledge engineering. The final outcome of KM and KE is decision making on the processed knowledge.

Decision Support Systems (DSS) are human-computer decision-making systems to support the managerial conclusion and beginning to solve managerial problems by providing necessary information, generating, evaluating and suggesting decision alternatives.

The Data-driven DSS help managers to organize, retrieve and synthesis the large volumes of relevant data where as the Model-driven DSS use formal representation of decision models and provide analytical support using the tools of decision analysis, optimization, stochastic modeling, simulation, statistics and logic modeling [3]. The

 DOI : 10.18231/2454-9150.2018.1399

web-enabled or web-based DSS as services offers decision computation technologies as services on the web. Web-based DSS is computerized system that delivers decision support information or decision support tools to a manager or business analytics. The web enabled DSS provide services for matching consumers, providers and web enabled decision computation services. To integrate the models for decision support system the web services approach can be used.

B. Web Services

Web Services an emerging technology that flows the mechanism of communication between the electronic machines and reuse of component of services over the web. The Web provides a golden bridge to the business agencies. In order to improve the business to business interactions, the service providers are providing a wide spectrum of online services.

In the distributed computing environment transformation of a message or involving a method in a remote system situated elsewhere in the network is possible through the middleware like RMI(Remote Method Invocation), CORBA (Common Object Request Broker) and DCOM(Distributed Component Object Model). But these technologies fail to extend the full support to the platform independence, language independence and easy transportation across the firewalls.

The major elements of web services are Service Registry, Service Consumer and Service Provider. The Service Provider develops the various services and publishes the services in the Service Registry. The services are published with its technical and non technical abstract details in the Service Registry. For publishing the services the web services are described with its name, purpose, available location using the WSDL structure. The Service Consumer who require the services place the request to the service registry in the form of queries or APIs(Application Program Interface). Then registry will respond to the consumer with the service providers' location. When the service consumers get the response from the service registry it the service consumer contacts the service provider through URI (Uniform Resource Identifier) and binds the link with the customer. Both service provider and consumer are using SOAP (Simple Object Access Protocol) for communication.

The service provider provides their services to the consumers in the form of web service in XML(eXtensible Markup Language) format and also it is published in the central Registry for utilization. In the business perspective this provider becomes the owner of the service. Using standard web protocols and networks such as SMTP(Simple Mail Transfer Protocol), HTTP (HyperText Transfer Protocol) these web services are accessed. Web services are powered by XML and three other core technologies WSDL (Web Service Description Language), SOAP and UDDI (Universal Description Discovery and Integration).

C. Business Process

A business process is defined as a collection of inter-related events, activities and decision points that involve a number of actors and objects, and that collectively lead to an outcome that is of value to at least one customer. [4]

Business processes represent a core asset of corporations. Business processes are what companies do whenever they deliver a service or a product to customers. The way processes are designed and performed affects both the "quality of service" that customers perceive and the efficiency with which services are delivered. An organization can outperform another organization offering similar kinds of service if it has better processes and executes them better.

Every organization let it be a nonprofit organization or a government body, or an enterprise it has to manage numerous processes. Business processes are what companies do whenever they deliver a service or a product to customers. The way processes are designed and performed affects both the "quality of service" that customers perceive and the efficiency with which services are delivered. The users usually describe the way to call the services with business process, of which the structure affects the overall QoS of the service composition, to achieve their business needs while composing services.

D. Model Driven Architecture

The web services composition the services have to be arranged in an order to build a composite service. Either the arrangement is at runtime or pre planned. The services use bottom-up or top down workflow to compose the services. There are different types of modeling languages used to develop the composite services. The main advantage of following model driven workflow pattern is reusability.

The popular techniques of model driven architecture are UML(Unified Modeling Language), PetriNets, BPEL (Business Process Execution Language), OWL-S (Web Ontology Language). These languages are applied based on the requirement of the business process or development process.

Using the existing workflow pattern of the particular language the composition models are built. Among the modeling languages Petrinet follows mathematical based modules. The OWL-S uses domain ontology for modeling.UML is also modeling language used to design the composition for web services. The BPEL also supports modeling the business process through its service partners activity. But the flaw in BPEL is unlike other languages it does not have its own graphical notation. In this research work to overcome the flaw of BPEL and to compromise the emerging need of web service industry the BPMN

 DOI : 10.18231/2454-9150.2018.1399

(Business Process Model and Notation) is translated in to BPEL.

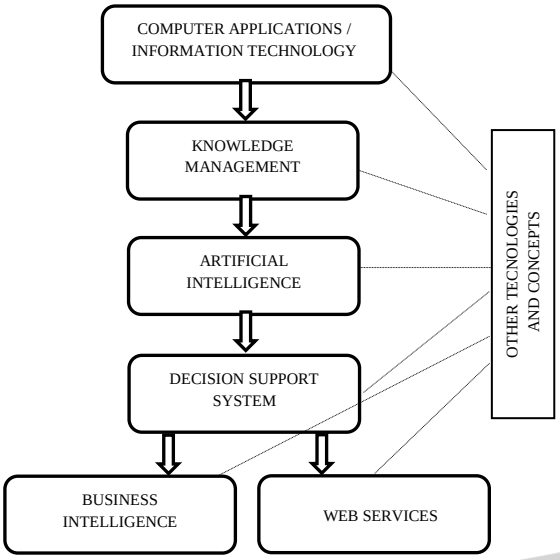

Fig. 2. General flow of Technology

II. RELATED WORK IN COMPOSITION OF WEB SERVICES

Mamoun Mohamad James [5] proposed a method to discover the services from the Service Registry based on non-functional parameter classification. In the study the authors stated the defect of ontology based classification as the same web service may be classified differently for different ontology.

K S May Chan *et al*. [6] compared various AI planning methods such as AND/OR Tree, HTN Planning, Situation calculus, Markov Decision Process and Planning based on model checking for composition of web services. In this conclude that the enhanced HTN, which is combined with POP is most suitable for composition of web services.

Ayoub Sabraoui *et. al.* [7] proposed a Model Driven Architecture approach to compose the web services. In this paper the modeling method they have considered is UML. The composition is made through operators matching. The derived model is from WSDL to UML is transformed to BPEL for composition. The Atlas Transformation Language (ATL) is used convert the derived model from UML to BPEL. In addition to this the authors stated that the existing similar models are not turned into executable process.

Khai Tan Huynh *et. al*. [8] proposed logic-based clustering approach to handle very huge volume of web services during composition of web services to reduce complexity. This approach separates original repository of web services into number of clusters. Moreover this approach maintains the soundness and completeness of the composition solution.

Corradini, F. *et al.* [9] developed a product called BProVe which is a novel verification framework for BPMN. This model is validated against the available real models.

Laden Aldin *et al*.[10] proposed a comparative analysis of the business process modelling techniques such as Flow chart, Petri net, data flow diagram, role activity diagram, BPMN, Business use cases, Business Object Interaction Diagram. These modeling techniques are compared according to five criteria: flexibility, ease of use, understandability, simulation support and scope. The applicability of each model is discussed with simple student enrollment scenarios.

III. METHODOLOGY

A. General Background

The Decision Support System (DSS) and Business Intelligence (BI) are emerging and pervasive area in the field of Knowledge Management and Artificial Intelligence which are using web services as their key implementation technology. Due to the plenty of web services available through public and private registries it increases the complexity in selection and composition of web services.

Business scenarios have updated and emerged in a new platform along with the revolution of internet and the World Wide Web evolution. Similarly, the classical technologies struggling to support the current requirements of business process management (BPM) such as business process integration, rapid and reliable decision making. It utilizes the distributed computing approaches to overcome the complexity in business process execution and management. Different technologies like SAP (Systems Applications Products) in data processing and manipulation are being used to implement business intelligence. As the business world is required to eliminate its boundaries in IT communication and transaction processing the web services are being disseminated in all respective business processes.

BPMN uses BPDs to describe business processes. A BPD is made up of BPMN elements. A set of BPMN graphical elements can be used to build BPDs covering the fundamental control flows in BPMN

The elements are categorized as objects and sequence flows. The object element can be an event, a task, or a gateway. While designing a BPD, to connect any of these objects the sequence flow elements could be used. BPMN uses BPDs to describe business processes. A BPD is made up of BPMN elements. A set of BPMN graphical elements can be used to build BPDs covering the fundamental control flows in BPMN

B. Composition of Web Services

A single web service is not proficient to perform complex tasks. Therefore, it is necessary to combine the functionality of several web services. The process of combining and

 DOI : 10.18231/2454-9150.2018.1399

linking existing web services to create new web processes is known as web service composition. The end product of the composition is called a composite service [11]. The participating services involved in the composition can be either simple or composite services. Generally, a travel agent service (S1 TA) as depicted in Fig. 2 is a composite service. The user submits their request to S1 to arrange for a pleasure trip. Then the S1 service has to book for flight, hotel rooms and local cabs. During the process the S1 service should verify the payment process also. If S1 is doing all these process solely then it is long and complex process. So as per modularity concept the different types of services are carried out by separate web services. In this travel agent service, the services for Flight ticket reservation (S2), Credit card verification (S3), Hotel room reservation (S4) and Local tour (S5) are composed together to deliver the final resultant service S1 to the consumer.

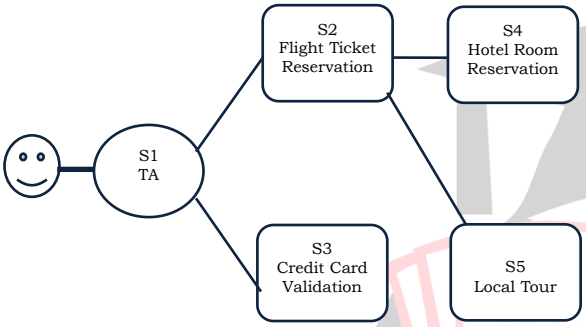

Fig. 4. Travel Agent Service

Composition of web services is established into three phases. They are Discovery of services, selection of right services and planning of composition.[6] In this the discovery of services has been done with the syntactic matchmaking algorithm (parameter checking). Selection of services also done on the most relevant services found (History data base is maintained to have the recently used services). Planning techniques like Petri nets, π – calculus, UML and AI (Artificial Intelligence) planning are available and languages like BPEL are used to do the composition of web services. As the Petri nets, π – calculus and UML needs the mathematical conversion tools and modeling tools. Compared To these techniques AI planning techniques are more relevant for the real time applications.

Various Artificial Techniques presented for planning such as breath first, depth first, best first, POP (Partial Order Plan), HTN (Hierarchical Task Network) etc. To compose the services the first requirement is decomposition of the goal state. This decomposition is not available in breath first and depth first. POP supports the decomposition of activities [12]. Despite, it (POP) suffers from the limitation of more number of open preconditions (i.e. precondition not achieved by any action). It can be overcome by HTN and it has major limitation it causes recursive decomposition. In order to overcome the limitation of HTN, a modified POP is integrated with HTN also the preconditions of the services are considered. Similarly, the dependency of failure or cancelled services is included in the modified planning algorithm.

In the Figure 4 if all the preconditions are met then the Travel Agent (TA) service S1 will invoke and call the service S2 (Air ticket Reservation) ,S3(Credit card validation). S2 will invoke the service S4 (Hotel Accommodation), S5 (Local Tour). If there is change in ticket reservation then that should reflect in hotel reservation. For example if the air ticket is cancelled then the hotel reservation should automatically be cancelled. This type of failure service dependency is not available in the existing models. That is at the time of decomposition dependency of services should be framed to do intelligent composition and backtracking. Failure nodes affect the efficiency of the planning.

C. Planning

The planning of composition of web services can be classified into two major categories such as i) Model oriented and ii) Process oriented. The model-oriented type uses the modeling techniques like UML, Petrinet, and Pi-calculus etc., to plan the effective and suitable composition model. The planned model is implemented using the supportive algorithms in the preferred language.

The process-oriented type of service composition uses the languages such as BPEL and OWL-S. Web services use BPEL for its service composition and OWL-S for semantic representation.

The model-oriented plan and process-oriented plan are just methods to be followed for the composition of web services. To create and design these plans, the planning techniques should be incorporated in these methods.

Planning plans the sequence of execution of the discovered and selected right services. Usually, the planning is done through the AI (Artificial Intelligence) techniques. Forward chaining and backward chaining are the two popular planning techniques used in the composition of web services. But these techniques are having some major disadvantages like, the forward chaining technique searches in the unnecessary directions and in the backward chaining the problem state is very large. To overcome this problem if the heuristics is included then it suffers from the local maximum problem.

To overcome all the aforesaid composition of web services issues the POP can be used. The only disadvantage in POP is cost overestimation by including the open pre conditions. HTN can overcome such issue and a complete HTN planning is undecidable even though the underlying state space is finite. To overcome this issues HTN is combined with POP. Still this technique is having the flaw of where to stop the process and more semantic in nature. Hence, in the proposed work the decision trees with the

 DOI : 10.18231/2454-9150.2018.1399

meta heuristics technique and the Genetic Algorithm (GA) is applied to find the right services and to generate the right planning trees with learning and reuse. Moreover, most of the business process follows some standard hierarchical structure. So the workflow management system has been maintained for easy and effective composition of web services.

D. Composition Models

In a web service environment, a workflow represents a composition of web services. When each activity of a workflow is implemented by a web service method, a composite web services is obtained. Number of composition of web services can be associated to the form the workflow, depending on the requirement of the business process model. The orchestration of the activities web services is defined by specifying dependencies between them. These dependencies are defined by the associated workflow patterns and by the transactional properties. The workflow specifies the association of web services and behavior of web service to influence another web services behavior. The transactional properties specify the behavior of certain web services in case of failure.

The Process Flow of proposed Composition Model is depected in Fig 6. The process of producing a web service composition can be generally viewed as starting with some global properties or dependencies (i.e. composition flow) that must be specified.

To model a workflow there are different modeling techniques available such as BPMN, UML, Flow chart, DFD (Data Flow Diagram), Role activity diagram, colored Petri nets, workflow techniques, Gantt charts. In this proposed work the BPMN has been used to model the workflow of a business process [7].

BPEL is a XML-based language that was designed to enable the coordination and composition of a set of Web services based on WSDL, which is essentially an interface description language for Web service providers. Web services composition using BPEL drives a new web service by composing a set of existing services and is known to be composite service.[6]

There are number of execution engines developed to support BPEL accompanying with a graphical tool which shows the direct code of the notations used. Hence, forcefully the developer should construct the BPEL for execution. As the abstraction level of BPEL is high and developer oriented it is difficult for the business analyst and designer to understand the workflow. Hence, BPMN is required for workflow pattern design and for executing the process definition the BPEL is required.

To make the bridge between BPMN and BPEL a mapping concept should be introduced so as to transform the structure and notations of BPMN into process definitions of BPEL. To make the pictorial representation of workflow of a business process in BPMN is implemented for execution through BPEL.

IV. FRAME WORK OF MODEL DRIVEN BASED WORKFLOW PATTERN

Business Process Modeling is a mechanism for describing and communicating the current or intended future state of a business process. It represents the steps, participants and decision logic in business processes. It is a combination of various process related steps such as Process Mapping, Process Discovery, Process Simulation, Process Analysis and Process Improvement. Organizations use this modeling to visualize document, to understand, and to improve their processes. Thus it facilitates the understanding of comprehensive business process.

To increase the efficiency of selection of web services the classification of web services based on non-functional attributed has been derived. An enhanced classifier algorithm is proposed to classify the services.[13].

The selection of services is performed using the non-functional QoS attributes such as response time, availability, performance and reliability. The refined most suitable services are ranked based on the normalized values of the QoS attributes[14]

The web services can be composed using the execution of the processes using the BPEL[15] . To compose the business process web services to reduce the complexity a model driven approach is followed using workflow pattern of BPMN. BPMN uses BPDs to describe business processes. A BPD is made up of BPMN elements. A set of BPMN graphical elements can be used to build BPDs covering the fundamental control flows in BPMN[16].

The elements are categorized as objects and sequence flows. The object element can be an event, a task, or a gateway. While designing a BPD, to connect any of these objects the sequence flow elements could be used. The derived model is transformed into executable using BPEL to give an efficient support to the decision makers.[17] To implement this enhanced depth first search algorithm is used enhanced algorithm is used.

Along with the created services the QWS data set is also used to derive the matching services, QoS parameter values and to frame the composition model

The Enhanced AND/OR Algorithm is used to integrate the selection of services using optimization modeling the composition services and transforming the modeled workflow into executable processing model. The model developed is WSWPM (Web Services Workflow Pattern Model).

Algorithm: Enhanced AND/OR Algorithm to frame entire Workflow

 DOI : 10.18231/2454-9150.2018.1399

Step 1 : Rank Services: Perform ranking for each web service selection and grading algorithm.

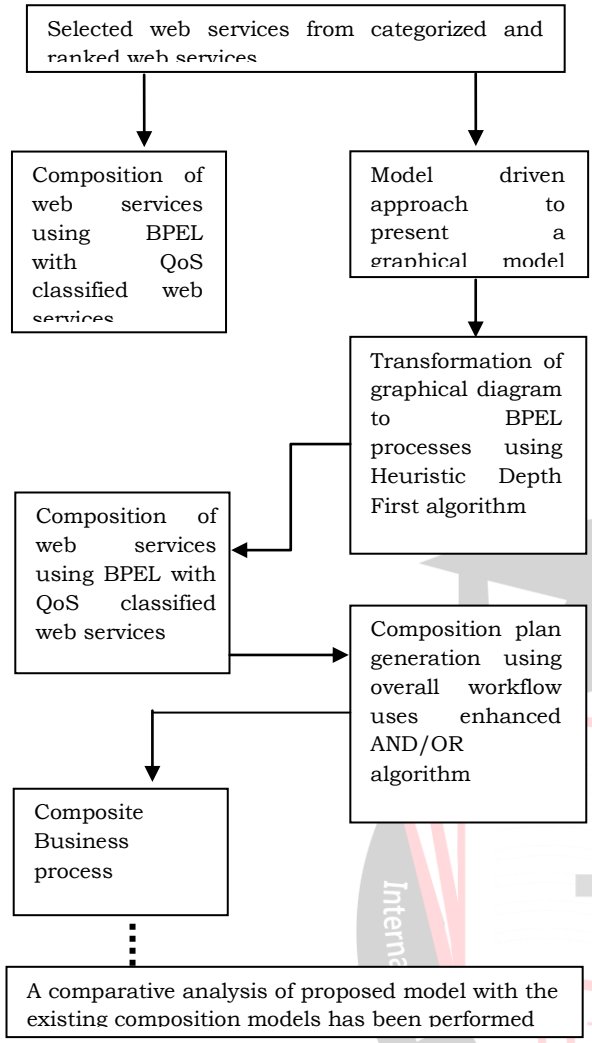

Fig. 6 Proposed Workflow Model (WSWPM)

Step 2: Classify the Web services based on their QoS using decision tree classifier and genetic search algorithm.

Step 3: Generate models using BPMN: Perform Mapping to Transform to BPEL

Step 4: Compute Service Composition. Generate all possible Composition plans by using Enhanced AND/OR tree search algorithm.

Step 5: Calculate QoS Aggregated value for each composition plan in BPEL Composition process and make a list of composition models.

Step 6: Normalize the composition models in the list using min-max procedure.

Save composite services that satisfy constraints in refined Composition models.

Step 7: Compute Aggregated QoS Rank for each composition model.

Evaluate all the Rank for each model. Keep the repository of models with Rank

Step 8: Calculate Final rank of models.

Sort and save the Composition model Plan in Ranked Composition Plan List (RCPL) based on Final Rank

Step 9: Execute all the Composition Plan in RCPL

Step10: Get feedback from the process executors and update.

V. EXPERIMENTAL RESULTS AND DISCUSSION

A. Product Comparison and Analysis

From [13], [14], [15], [17] the services are categorized and selected. The results are of the proposed research methods are better than the existing methods and are clearly discussed in the aforesaid papers.

The new composition model WSWPM developed using the concepts service selection. Classification of web services and model driven composition is with other existing models. The result is given in Table 1.

The existing methods eFlow, BPMS, selfServ, SHOP2 and sword are well designed they too do not support some of the key parameters as given in the table 1. But the proposed model overcomes the flaws in the existing methods and satisfies the user requirements effectively and efficiently.

VI. FINDINGS AND RECOMMENDATIONS

A. Findings

The performance of the proposed model WSWPM is more efficient when compared with the existing models.

1. The new model WSWPM is storing the derived models and it supports the reused artifact parameter.

2. The proposed model uses optimized QoS nonfunctional parameters which reduce the complexity of the appropriate selection of web services by the users.[14]

3. The existing models do not support graphical model where as the proposed does.

4. The integration of classification and selection of web services, building BPMN, transforming it to executable is performed by the workflow algorithm which enhances the support to the business process handlers to do the composite process automatically.[16]

5. The proposed model improves the efficiency of business process by selection of QoS, reduced time and graphical model representation.

 DOI : 10.18231/2454-9150.2018.1399

S.No.	Product	Reused Artifact	Reuse Technique	QoS optimization	Classification	Graphical View	Automation
1	**eFlow**	Components	Not addressed	Not Applicable	Not Applicable	Not Applicable	Dynamic binding of nodes with concrete services
2	**BPMS**	Transformation rules, and examples	copy/paste, forum	Not Applicable	Not Applicable	Applied	Not addressed
3	**Self-Serv**	Components, examples	Keyword search. UDDI Registry	Not Applicable	Not Applicable	Not Applicable	Service containers are bound with concrete services at run time
4	**SHOP2**	Components	Not specified	Not Applicable	Applied – Partially automated	Applied	Semantic-based composition using HTN planning
5	**Sword**	Components	Not specified	Not Applicable	Not Applicable	Not Applicable	Semantic-based composition using a rule-based planner
6	**YAWL**	Components, examples	Repository	Not Applicable	Not Applicable	Not Applicable	Not addressed
7	**WSWPM**	Transformation rules, and Examples	Repository	Applied	Applied - Automated	Applied	Automated

Table 1 Comparative Analysis of workflow models

B. Recommendations

This proposed model can be used in all the business process such as tourism, travels, healthcare, logistics, accounting, manufacturing, online services.

This WSWPM model is exceptional choice to implement in all business sectors since all the business processes are integrated with more than one process and services based on web.

Further this model can be enhanced by applying semantic match making while doing service selection.

The model shall be applied with Internet of Things(IoTs) to make better decisions during composition of more than one device.

VI. CONCLUSION

The presented research work uses the techniques such as selection of services based on QoS parameters, Categorization based on QoS and the workflow pattern based model driven composition to compose the business process web services to get an effective composition model. A composition model is derived to compose the services using the service selection and categorization. To improve the model further the workflow patterns of BPMN is used to drive the composition model and the enhanced branch and bound algorithm used in BPEL gives an efficient, user friendly composition model.

The new derived composition model is compared with the existing model and the performance is better. From the analysis of the result it shows that the new derived composition model is efficient compared with other models.

The present research mainly focused on composition of business process web services to help the end user to make decision to utilize the desired services. This Research work can be extended with security measures of web services during the composition of business processes.

ACKNOWLEDGMENT

We the authors of this paper wish to acknowledge the authors of the journal papers used for reference and the working institutions and for providing the support and encouragement to do the research work.

REFERENCES

[1] Harold J. Leavitt, Thomas L. Whisler “Change management, Management in the 1980’s” ,Harvard Business Review, From the issue of November 1958.

[2] Philip c. Murray, KM Briefs and KM Meazine, “What to know before you select knowledge management technology”,1997

[3] Hemant K. Bhargava, Daniel J. Power ”Decision Support System and Web Technologies:A Status Report”, Journal of Decision Systems,1998.

[4] Marlon Dumas, Marcello La Rosa Jan Mendling, Hajo A. Reijers , “Fundamentals of Business Process Management”, Springer 2013

[5] Mamoun Mohamad Jamous, Safaai Bin Deris, “Web Services Non-Functional Classification to Enhance

 DOI : 10.18231/2454-9150.2018.1399

Discovery Speed", IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 4, July 2011

[6] K. S. May Chan, Judith Bishop and Luciano Baresi, "Survey and Comparison of Planning Techniques for Web Services Composition",2008

[7] Ayoub Sabraoui, Ahmed Ettalbi, Mohammed El Koutbi, Abdeslam En-Nouaary, "Towards an UML Profile for Web Service Composition Based on Behavioral Descriptions", Journal of Software Engineering and Applications, 2012, 5, 711-721

[8] Khai Tan Huynh, Tho Thanh Quan, Thang Hoai Bui, "A quality-controlled logic-based clustering approach for web service composition and verification", International Journal of Web Information Systems, Vol. 13 Issue: 2, pp.173-198,2017

[9] Corradini, F., Fornari, F., Polini, A., Re, B., Tiezzi, F., and Vandin, A, BProVe:" A formal verification framework for business process models". Proceedings of 32nd IEEE/ACM International Conference on Automated Software Engineering (ASE) (pp. 217-228), 2017

[10] Aldin, Laden and de Cesare, Sergio, "A Comparative Analysis Of Business Process Modelling Techniques", UK Academy for Information Systems Conference Proceedings, 2009

[11] Gustavo Alonso, Fabio Casati, Harumi Kuno and Vijay Machiraju," Web Services:Concepts, Architecture and Applications", Springer Verlag, 2004.

[12] Kenneth Chiu, Indiana University, "Web services Performance: A Survey of Issues and Solutions",2005

[13] J. Ghayathri, Dr. S. Pannirselvam, "Categorization of Web Services based on QoS Constraint using Decision Tree Classifier", International Journal of Advanced Research in Computer and Communication Engineering, Volume5, Issue5, May 2016, ISSN:2319-5940.

[14] J. Ghayathri, Dr. S. Pannirselvam, "Selection of Paramount Web Service using Sentient QoS Parameters", International Journal of Computer Applications, Proceedings on National Conference on Research Issues in Image Analysis and Mining Intelligence, June 2015, ISBN: 973-93-80887-13-1.

[15] J. Ghayathri, Dr. S. Pannirselvam, "An Enhanced Method to Compose Business Process Web Services using BPEL and Optimized QoS Parameters", International Journal of Research in Engineering and Technology, Volume 5, Issue 6, June 2016, ISSN: 2321-7308.

[16] X. Tian, H.S. Li, Y.J. Huang, Q. Cai, "A Mapping Algorithm of Scientific Workflow from BPMN to BPEL", International Conference on Artificial Intelligence and Industrial Engineering ,Atlantis Press,(AIIE 2015)

[17] J. Ghayathri, Dr. S. Pannirselvam, "Transforming Model Driven Based Workflow Pattern into Executable Processes using Heuristic enabled Depth First Traversal Algorithm", International Journal of Emerging Technologies and Innovative Research, Volume 4, Issue 9, September 2017, ISSN:2349-5162.

 DOI : 10.18231/2454-9150.2018.1399