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Research paper

Evaluating the QoS Cognizance in Composition of Cloud Services: A Systematic Literature Review

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Abstract

Enterprise level computing constantly investigates novel approaches that maximize their profits and minimize their expenses. With the rapid growth of cloud computing XaaS – 'anything as a service', service providers are enabled with the rapid deployment of virtual services to service requestors. Because of the enormous growth in the variety of the services and based on the demand of the virtualized resources, cloud service providers are facing tough competition to facilitate the composite service requests made by the service requestors. QoS (Quality of Service) is considered to be a preliminary factor while composing a new cloud service out of heterogeneous and distributed atomic services. Therefore service composition is promising area that focuses on the design and development of the automated approaches to deal with diverse phases of service composition techniques that include service discovery, negotiation, service selection and optimization of the atomic services. This paper provides anatomy of existing studies addressing the problem of cloud service composition that enable to identify intended objectives of the technique along with diverse QoS aware problem solving approaches. Furthermore, the key areas of the improvement in cloud service composition are identified for future research.

Keywords: *Service Composition, Service Coordination, Cloud Services, Composite cloud service*.

1. Introduction

Service composition was introduced and investigated for web services in the early 2000's [1] [2] [3]. Diverse classical and evolutionary algorithms have been extensively investigated and developed to resolve the problem of service composition in web services. It is observed that novel frameworks and workflows have been designed to illustrate the process in which the numeral atomic services are composed to form a composite service to accomplish goals specified by the service requestor. Application of service composition techniques in cloud environment was initially started in the year of 2009 by Kofler, ul Haq, & Schikuta [4] to optimize QoS (Quality of Service) in cloud environment. Further substantial effort is being made by many researchers in this area, such that the ongoing studies indicate that there is a rapid growth in the number of articles addressing the problem in recent years. A glimpse of reliable works in this area enables us to identify the researchers interested in this promising area along with their research studies that include novel ideas, algorithms, frameworks and approaches with the expanding scope of problems in this area.

In cloud environment, dynamic and scalable services are to be provided to the service requestor based on their needs. Cloud Service composition is considered as NP-Hard problem [5] as the heterogeneous services are integrated from the large service pool to serve the client request. The key idea of service composition mainly focus on design and development of new cloud services based on the integration of previous services to improve the efficiency and reduce the cost and time. Besides, it focuses on the application of selection, negotiation, and optimization strategies to identify the best service from available services enlisted in discovered services.

The current research aims to collect and investigate various effective and credible studies addressing the problem of service composition in cloud. In specific, the objective is to conduct a systematic review on various composition mechanisms that realizes the need of research in this area. The fundamental goal of the survey is:

- To provide the methodical study of existing techniques addressing the problem of service composition that include approaches and algorithms used for service selection, service composition, service orchestration and optimisation of the composite services.
- To study the anatomy of essential techniques that resolve the service composition problem
- To enumerate the assessment methods, benchmarks, and datasets used by the researchers to analyze the QoS parameters of techniques proposed under cloud service composition
- To identify the scope of further research in cloud service composition

The structure of this paper is ordered as follows. After the introduction, section 2 includes the background of service composition mechanism in the context of cloud computing. Section 3 includes the research methodology to develop selection mechanism intended to identify reliable studies particularly addressing the problem statement. Section 4 includes the glimpse of selected service composition mechanisms. Section 5 provides results and insights from the existing papers. Also, Section 6 maps out same open issues. Finally, Section 8 concludes the paper.

2. Background

2.1. Cloud Service Composition

Service composition indeed refers to the design development of the new service through the existing one and this integration of enterprise application has gained the momentum to realize B2B collaboration in the context of e-commerce. The main problem in service composition lies in the aspect of QoS aware integration of atomic services that are developed based on multiple approaches and technologies. Such that this kind of integration may be error-prone, delicate requiring system administration efforts with a significant amount of low-level programming.
In the process of requesting and providing a service, before a service is enabled to the service requestor the service provider makes an entry of the service in the service registry or repository. Web service standards such as SOAP [6], WSDL [7], UDDI [8] and XML [9] handle the entire data exchange during the communication process. Furthermore, these standards play a vital role in the development and deployment of Service-oriented Architecture (SOA) application. Depending on the consumer request various web services were composed in the perspective of developing service oriented architecture. Example composed services include web services that enable access to larger data sets through Big data-as-a service for the data stored in cloud data centres.
Cloud computing is considered as most accepted technology adopted by small and large enterprises to accomplish the development efforts with the top-line development tools and helps the IT industry in the notable reduction of development cost with virtualization. Because of this, there is fast growth in the utilization of cloud services consequently increasing the demand from the consumers in variant of queries. Automation of the process of analysing the consumer request and processing them by developing a composed web service caught the attention of various researchers by classifying them as the functional aspects (**Klusch, Fries, Khalid, & Sycara, 2005)** [10] and approaches addressing the service oriented aspects**.** Research in service composition mechanism was processed in three different directions that include developing process models that specify data flow among the activities in SOA, service selection and binding the concrete services within the process model and service execution. Many organizations provide similar web services to the variant of clients based on their request.
Similar web services enabled to the consumers over the internet could be classified based on functional, non functional attributes and their disparate capabilities. The functional attributes always address the purpose of developing the atomic web service and its individual task processing. Besides non functional attribute always concentrate on the Quality of Service (QoS) that indicate the level of quality in which a service is composed. QoS metric is primarily used in the case of services having similar functional attributes. Hence QoS is needed to be considered as stochastic and decision problem during service composition under uncertainty. In the process of QoS analysis the services are identified as beta-distributed random variables such that most optimistic, pessimistic values of services are utilized for beta-distribution. In general, QoS could be obtained by monitoring the system in two different perspectives that include client and server. QoS at the client side may include response time, throughput and server side may include
The cost price of the service and the service response time are devised a beta-distributed and independent random variables. The beta distribution of the variables are consequently determined by the most optimistic and pessimistic values of the service. In specific cases the QoS metrics are represented as diverse distribution functions. In certain cases the distribution of QoS metric may absolutely be of any shape, such that a recognised statistical distribution will not able to reflect the irregularly shaped distribution in a precise manner. Based on the metrics shown in Table 1 the QoS can be obtained through the continuous monitoring of the variations in the QoS metrics using various strategies.

Table 1.QoS Metrics

QoS Aspect	Description	Fitness indication of the Metric
Response time	It indicate the quantitative difference of the time period from consumer request initiation to request completion	Low is better
Execution Time	It indicate the time taken for a particular web service to accomplish the task	Low is better
Reputation	Ranking of the services based on the consumer satisfactory rate	Higher is better
Cost	It indicates the quantitative monetary value that is required to execute the service	Low is better
Availability	It indicate the accessibility level of the service in a particular time frame	Higher is better

2.2 Problem Statement

With the growing demand of the cloud services in the commercial market there exist diverse cloud service providers that would provide vast range of similar services that may differs with minor operational and computational features. In many cases, provisioning of a single service may not be able to satisfy the consumer's requirement in such aspects the services offered by multiple cloud service providers are needed to be integrated. This context refers to web service composition in which a composite service is devised by integrating the functionalities of atomic web services. QoS attributes and functionalities of the services plays a vital role during the composition of the services. The evaluation of the QoS attributes of a particular service is taken into consideration only when a similar service is being offered by different cloud service providers. On evaluating the QoS attributes of a service we can select the best service that could satisfy the consumer requirement and optimize the process of service composition. The service composition process is similar to the concept of integration in the workflow management systems [30]. In general a workflow management system includes a model with a set of transitions and tasks, where the data is processed through the system until the objective is accomplished. Similarly, in the case of service composition a workflow model is utilized to integrate QoS attributes the web services and optimize the process of service composition as shown in the below Figure 1.

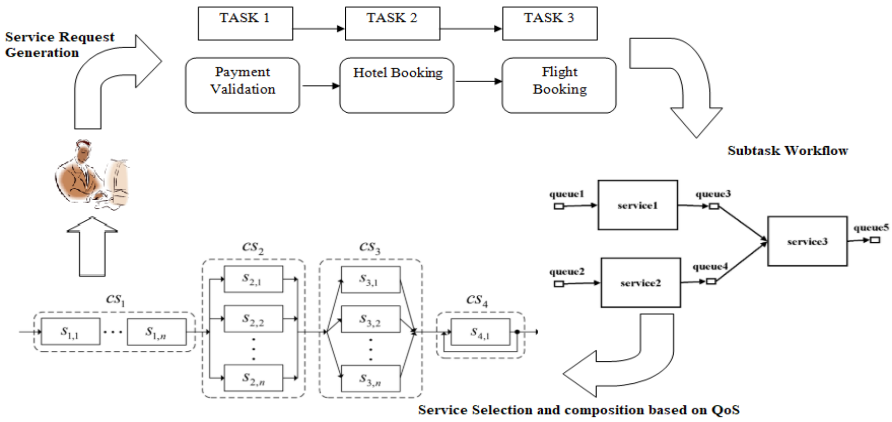

Figure 1: Cloud Service Composition

3. Research Methodology

A systematic literature review (SLR) on the various service composition mechanisms in specific to the cloud environment is conducted to identify and analyse the potential techniques and their experimental results. An SLR aims to provide a comprehensive summery on the recent research progress in particular to the service composition domain such that, it enables to identify the existing research challenges and ongoing research in particular domain. The methodology adapted is shown in Figure 2.

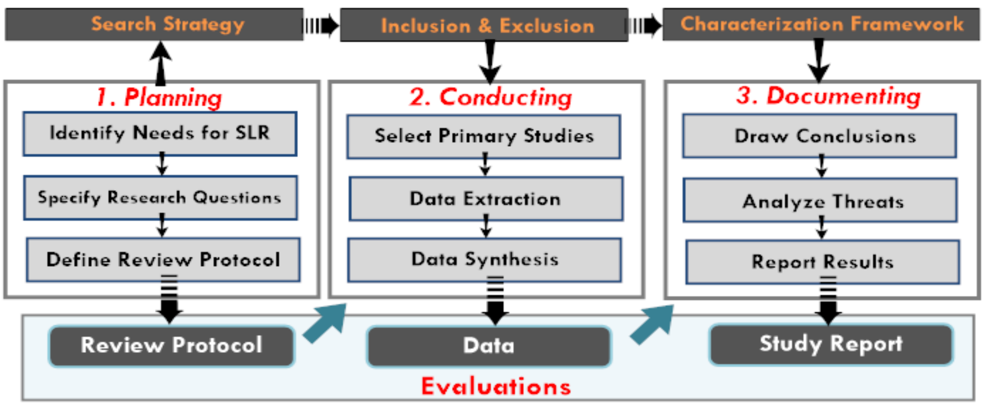

Figure 2: Overview of Research Methodology

- Initially questionnaire is formulated to analyse and extract the silent features and methods from the reliable research articles considering the survey goals mentioned above.
- Developing the review protocol that include search strategy, data extraction methods.
- Formulating the inclusion and exclusion criteria.
- Comprehensive review on the selected articles is illustrated along with their assessment methods
- Identify the research gaps to recognize the open research challenges

3.1 Questionnaire Formulation

Virtualized cloud service life cycle is comprised of five phases that includes service requirements, service discovery, service negotiation, service composition, and service consumption. Besides all the phases, service composition plays a vital role in serving the customer request by composing the atomic services in to a composed service to solve complex problems. In order to achieve survey goals mentioned above and examine the techniques that have been adapted and developed by researchers for their studies and assessment methods, case studies are covered by following questionnaire:

Table 2: Questionnaire Formulation

Service Composition	
S.No	**Questions**
	What are the Challenges in analysing user requirement satisfaction such that the composed service should strictly abide by the customer requirements?
2.	To what extent the improvised QoS based mathematical model developed to evaluate the composite services
3.	What are the problems in identifying qualitative QoS parameters used for decision making and transform them to quantitative values based on reliable techniques?
4.	Design a self adaptable and automated service composition mechanism to address the dynamic changes in cloud environment
5.	Explain the importance of adapted data structures and databases used in the process of designing an efficient algorithm.
6.	Algorithm improvements developed to address the problem of cloud service composition to obtain best services in terms of QoS
7.	Demonstrate the techniques for optimising service discovery process

3.2 Search Strategy

The main objective of the preliminary the search process is to discover reputed and reliable, journal and conference articles on service composition mechanism in cloud environment. The search process is conducted on scientific databases via electronic searching. Initially the following keywords and electronic databases are identified for searching process is enumerated in table.

Table 3: Search Keywords and Electronic databases

Cloud Service	"ORed" and "ANDed"	Google scholar (https://scholar.google.com/)
Cloud Service Composition		Springer (http://link.springer.com/)
Service Optimization		IEEE explorer (http://ieeexplore.ieee.org/)
Service integration		Science Direct (http://www.sciencedirect.com/)
Service Level Agreement (SLA)		Sage (http://online.sagepub.com/)
QoS Parameters		Taylor (http://www.tandfonline.com/)
Performance analysis of cloud services		ACM (http://www.acm.org/)
User trust evaluation		Emerald (http://www.emeraldinsight.com/)

A preliminary literature investigation on cloud services identified 950+ articles based on the combination of the search string when applied on the scientific databases like IEEE explorer, Springer, Science direct, Taylor and Francis, ACM and Emerald. Among which the articles are filtered to 272 based on the practical screening criteria to make sure that high-quality articles as well as publications are included in the review. By means of this strategy, it is identified that 35% of articles are related to IEEE conference, and 10% of articles are from IEEE journals, 15 % of articles are from Springer whereas 18 % of articles are related to science direct and 12% of the articles from ACM, Furthermore, 5% are from Taylor and Francis, 2% from Emerald and the remaining 3 % of articles from standard conferences like International Conference on Parallel and distributed computing, International conference on Service Oriented Computing.

3.3. Qualitative assessment and Study Selection

Based on the studies retrieved by the manual and automated search strategy, each article was examined by the author and his both supervisors such that divergences were accorded among the authors as the following studies were taken into consideration if they met atleast one among the inclusion criteria enumerated below:

- Studies that explained proposed work clearly and obviously in an evidence based evaluation scenario
- Studies related to design and development of classical and heuristic algorithms to address the cloud service composition problem

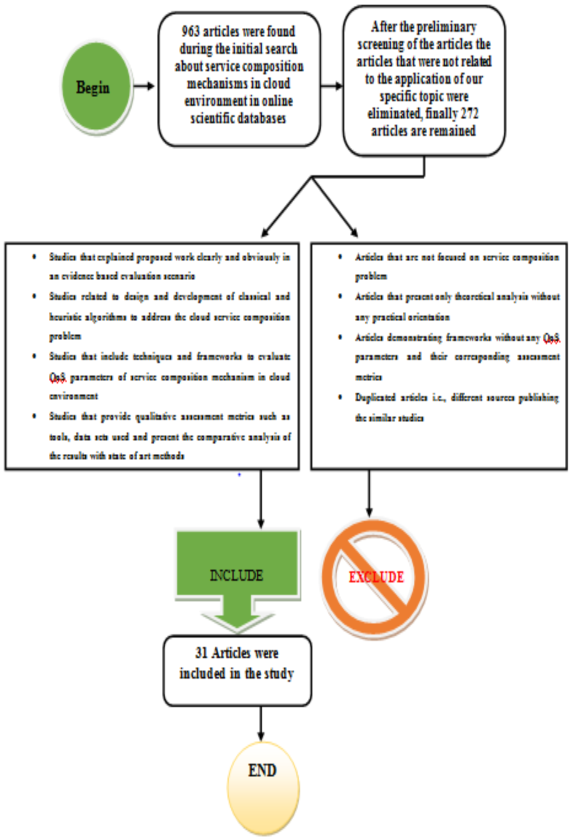

Figure 3: SLR Process

- Studies that include techniques and frameworks to evaluate QoS parameters of service composition mechanism in cloud environment
- Studies that provide qualitative assessment metrics such as tools, data sets used and present the comparative analysis of the results with state of art methods.

The subsequent articles were excluded if they met atleast one of the exclusion criteria:

- Articles that are not focused on service composition problem
- Articles that present only comprehensive analysis without any practical orientation
- Articles demonstrating frameworks without any QoS parameters and their corresponding assessment metrics.
- Duplicated articles i.e., different sources publishing the similar studies
- Articles that are not written in the English language.

4. Related Work

The following table illustrates the articles taken into consideration for critical study in which the research gap is claimed based on few extracted data fields. The fields include author, year and details of the paper followed by its objective, methodology and future directions as well as limitations.

Kofler et al.[15] to attain an optimized concrete workflow of a QoS aware cloud service composition that satisfy the consumer requirement proposed a parallel form of the branch-and-bound algorithm. A multi-choice and a multi-dimensional knapsack problem with a consumer satisfactory rate as a parameter is considered to evaluate the QoS requirement of the consumer. The proposed algorithm consists of a decision tree in which each node act as an independent entity of the main program. Every such entity consists of two parameters such that firstly a partial decision vector which is considered to be the fixed decision of the sub problem and the parent node of that particular entity in the decision tree. The algorithm is evaluated based on four randomly generated problems such that the researchers have executed the problems in series and parallel modes and generated results based on comparative analysis against each other. It is identified that the algorithm faces exponential complexity during the performance evaluation. A dual phase approach is also presented in Kofler, Haq, and Schikuta (2010) [15] to resolve the problem of high execution time in this method.

Zeng et al. (2009) [16] designed a framework to store and search the cloud services effectively based on the context of data saving method under cloud resources. The proposed storage strategy will be efficiently scalable to adapt a new web service such that it improves the effectiveness of service composition. Further, the researchers proposed a SMA (service matching algorithm) that could be applicable in the storage such that to analyse the composition levels of the atomic cloud services based on the approach in which the algorithm analyse whether the output of one service is matched with the input of another service. Based on the semantic similarities of the input/output parameters the matching degree is identified and stored in the table. Furthermore a weighted graph is generated such that to identify the all possible paths between two nodes that can yield all of the possible service composition methods. A Fast-EP and FastB+ - EP algorithms are proposed to obtain all the possible pats in the faster time. However, the proposed algorithms exhibit high execution time and decreased algorithm performance if the size of the problem is increased.

Mixed integer programming (MIP) is a two phase method proposed by Zhu et al. (2012) [17] to analyse the performance metrics of cloud service composition in dynamic cloud environment. In the initial phase of the method K means algorithm is adopted to reduce the count of the candidate single services , in which few appropriate services are selected based on the history of the single services. In the next phase the concept of Mixed integer programming is utilized to identify the best single services for the process of composition among the initially selected services. The author in his paper proved that his proposed two phase approach outperforms the HireSome approach proposed by Lin, Dou, Luo, & Jinjun, [18].

A Three layer hierarchical model is designed by Liu et al. in [19] evaluate the user preferences and the various resource characteristics integrated together. The initial layer enables the process for optimal service selection, the second layer classify the selected web services into various categories based on their performance metrics that include security, stability and timeliness of the service and the last layer is devised to analyze various additional QoS parameters. These phases collectively generate a user requirement matrix based on the evaluation of the user preferences and weights are assigned to the QoS parameters using AHP (analytical hierarchy process) that generate and normalize the service parameter matrix. This process is accomplished by the algorithm named as SSUP (service selection based on user preference). The author indicated that the proposed SSUP algorithm outperforms the process of AHP in solving service composition problem.

Liu et al. (2012) [20]. Proposed a workflow model in which initially it utilizes the state transition matrix to analyse the execution of dynamic service composition in which the status of each composite service is modelled with the help of a state transition diagram to generate a state transition matrix. This matrix is further utilized to compute the execution cost of composite services. Further the author adopted BEPL4WS (Business Process Execution Language for Web Services) to devise the optimal solution. As BEPL4WS is considered as a time consuming process because of its distributed traffic nature, the researchers have modelled the techniques in three parts and execute the same in various independent systems.

Worm et al in [21] proposed a technique based on three decision criteria that aims to maximize the revenue and quality assurance. The concept of dynamic programming is utilized to evaluate the decision criteria based on execution cost, service availability at the particular instant of time. Additionally , in this case of a deadline, an influx decision rule will identify the services with the execution cost for the further tasks. The proposed algorithm is executed in the context of dynamic and static service composition but they make use of benchmarks as well as real-world datasets to compare the results with the previous research; The drawback of this approach is the memory complexity as well as the computation time are neglected.

Ludwig et.al in [22] the context of self-adaptivity within the service provisioning system, an enhanced genetic algorithm is presented in which instead of tournament selection, a clonal selection algorithm is utilized to filter the individual services for the purpose of crossover and mutation operators in a more distinct manner. The description of the proposed algorithm along with the experimental results in the original paper does not specify the details regarding the researchers' work on self-adaptivity.

Bao and Dou (2012) [23] considered finite state machines (FSMs) to think about rightful task executing sequences as well as service correlations, in which each FSM is utilized to execute a group of services with limitations on their executing sequence as well as the invocation called CWS community furthermore another FSM for a required composite service called the target process. The proposed method is unruffled in two phases. Initial phase includes a service composition tree that is created based on CWS community along with the target process. A pruning policy was functional utilized in the elimination of inappropriate paths of the tree that consequently reduce the processing time. The QoS of all paths within the tree were computed in the next phase based on consumer requirements, and the path with the highest QoS is selected as the final solution. To reach this goal, a dichotomous simple additive weighting technique is used in the first part, from which the scaling of paths is performed by dividing them into negative and positive criteria, and in the second part, the total QoS of all of the paths is calculated. Researchers could prove appropriate efficiency of their proposed methods by comparing its executing time with the executing time of the enumeration method.

Author and Year	Details of the paper	Objective	Approach	Future Directions/ Limitations
Klein, Ishikawa, & Honiden (2014) [24]	Services Computing, IEEE Transactions on	Self adaptive Network aware QoS evaluation for service composition	Genetic algorithm	Evaluate the proposed approach in large-scale distributed environment
Mostafa & Zhang(2015) [25]	Services Computing, IEEE Transactions on	Handle multiple quality objective in dynamic environment	Framework based on Multi-objective approach	Study impact of the relationship among multiple quality objectives.
G. Fan, Yu, Chen, & Liu (2013) [26]	The Journal of Systems and Software, Science direct	Identify interrelationships of the atomic services that are to be composed	Reliable service composition approach model	develop a personalization standard with multiple-level solutions for a personalization framework
A. Singh, Juneja, &	Journal of King Saud Uni-	Intelligent service provi-	Automated assignment strat-	Not Mentioned

Malhotra, (2015) [27]	versity Computer, science direct	sioning	egy using intelligent agents	
Jula, Othman, & Sundararajan (2015) [28]	Journal of Expert Systems with Applications, Science Direct	Service Time Optimization in Cloud Computing Service Composition	Classified Search Space Imperialist Competitive Algorithm	Designing novel operators for ICA (Imperialist competitive algorithm)
Kurdi et al. (2015)[29]	Journal of Computers and Electrical Engineering, Science Direct	Service composition in multi cloud environment	Combinatorial Optimization Algorithm For Cloud Service Composition	Not Mentioned
Zhao, Shen, Peng, & Zhao(2015) [30]	Journal of information Sciences, Science direct	Optimization problem in SLA-constrained service composition	fuzzy preference model	Not Mentioned
X. Wang, Cao, & Xiang (2015) [31]	Journal of Computers and Electrical Engineering, Science Direct	Service selection in multicloud environments	Dynamic cloud service selection algorithm	Design an interactive mechanism between cloud service brokers
Qiang Yu, Chen, & Li (2015) [32]	Journal of Computers and Electrical Engineering, Science direct	Service composition in multicloud environment	Greedy-WSC ACO-WSC,	semantic information in web service composition, especially in a distributed and dynamic environment
H. Wang, Wang, Hu, Zhang, & Gu (2016) [33]	Journal of information science, Science direct	Dynamic web service composition	multi-agent reinforcement learning model based on Web Service Composition Agents(WSCA)	Reduce the communication cost between the agents
Gutierrez-Garcia & Sim(2013) [34]	Journal of applied intelligence, Springer	Service composition in multi cloud environments	Designed a semi-recursive contract net protocol for agent communication	Not Mentioned
Ivanović & Carro (2014) [35]	International conference on Service-Oriented Computing, Springer	Scalability of the service composition	Service orchestrations with centralized control flow	High Execution Time
Bastia et al.(2014) [36]	Intelligent Computing, Communication, and Devices, LISS 2014, Springer	Service composition in Multi-cloud environment	Multi-agent approach	High execution Time
Huo, Zhuang, Gu, Ni, & Xue (2015) [37]	Journal of Applied Intelligence, Springer	Optimal Service composition	Bee colony algorithm based approach	High Cost
Kholidy, Hassan, Sarhan, Erradi, & Abdelwahed (2015) [38]	International conference on Internet of Things. User-Centric IoT, Springer	multi-objective optimization in Cloud service composition	Genetic algorithm based approach	High Time
Karimi, Isazadeh, & Rahmani (2016) [39]	The Journal of Supercomputing, Springer	Service compositions according to SLA	data mining techniques	High Overhead
B. Huang, Li, & Tao (2014) [40]	Journal of Enterprise Information Systems, Taylor and Francis	Cloud service composition optimal-selection	chaos control optimal algorithm	Improve time consumption
Lartigau, Xu, Nie, & Zhan (2015) [41]	International Journal of Production Research, Taylor and Francis	geo-perspective correlation in multi-cloud domain	Optimization based on artificial bee colony algorithm	High Execution time
H. Zhang, Guo, & Geng (2014) [42]	Journal of Intelligent Materials and Mechatronics, Scientific publications	Analyse characteristics of services in cloud manufacturing	Mathematical Model combined with optimization algorithm	Low scalability
Kofler et al. (2009) [15]	International conference on parallel processing	Evaluate QoS parameters based on consumer requirement	Heuristic Algorithm (Parallel branch and bound algorithm)	Analyse fault-tolerance to cope up with dynamic service failures
Zeng et al. (2009) [16]	Cloud Computing, Proceedings (5931, pp. 290–300). Berlin: Springer-Verlag Berlin	Service matching based on semantic	Heuristic algorithm (service matching algorithm)	Not Mentioned
Zhu et al. (2012) [17]	In Service-Oriented Computing and Applications (SOCA), 2012 5th IEEE International Conference on (pp. 1–8	Service Composition in dynamic cloud environments	Heuristic algorithm (Mixed integer Programming)	Compare the proposed approach with other approaches dealing dynamic QoS Variations
Liu et al. (2012) [19]	Intelligent Control and Automation (WCICA), 2012 10th World Congress	Reduce the Execution Cost of Service Composition	Graph Based- State transition Matrix based Approach	Not Mentioned
Liu et al. (2012)[20]	International Journal of Advancements in Computing technology	Service Selection based on user preference	Service selection based on User preference and AHP(analytic hierarchy process)	Optimal Service Selection
Worm et al(2012)[21]	ServiceOriented Computing and Applications (SOCA), 2012 5th IEEE International Conference on	Revenue Maximization and Quality assurance	Dynamic programming based approach	Time complexity of the proposed approach in the context of revenue maximization policy
Ludwig et.al (2012) [22]	Evolutionary Computation (CEC), 2012 IEEE Congress on	Self-adaptivity of the service provider system	Clonal selection based genetic algorithms	Parallelization of the proposed algorithm
Bao and Dou	IEEE 26th international	Service Correlations and	Finite state Machine with	Not Mentioned

(2012) [23]	parallel and distributed processing symposium workshops & Phd Forum	executing sequence	Tree pruning based algorithm	
Qi and Bouguettaya (2013) [43]	IEEE Transactions on Knowledge and Data Engineering	Selection of the best atomic services for service composition	One Pass Algorithm Dual Progressive algorithm and bottom-up algorithm	To exploit data incomparability
Jula et al (2013) [44]	IEEE Workshop on Memetic Computing (MC)	Optimization of QoS attributes	Imperialistic competitive algorithm and gravitational search algorith	Not Mentioned
Dou et al. (2013) [45]	IEEE Transactions on Parallel and Distributed Systems	Improve reliability of service composition	Task service tree based algorithm	Apply the proposed approach on big data applications
Karim et al. (2013) [46]	IEEE Ninth World Congress on cloud service selection	Select and rank best atomic services for service composition	AHP (Analytic Hierarchy process)	Conduct experiments based on the performance evaluation

5. Results and Discussions

The following table identifies the insights in the previous research studies to identify the variant of QoS properties analyzed in studies

Author and Year	QoS Parameters Considered
Kofler et al. (2009) [15]	Response time (RT), Cost
Zeng et al. (2009) [16]	Response time (RT), Availability (Avail), Reliability (Reli)
Zhu et al. (2012) [17]	Response time (RT), Cost, Availability (Avail), Reputation (Reput)
Liu et al. (2012) [19]	Cost, Throughput(Thr)
Liu et al. (2012) [20]	Trust, Maintainability (Maint), Function similarity (FS)
Worm et al(2012) [21]	Response time (RT), Cost, Availability (Avail)
Ludwig et.al (2012) [22]	Response time (RT), Cost, Availability (Avail), Reliability (Reli)
Bao and Dou (2012) [23]	Response time (RT), Cost, Reliability (Reli), Availability (Avail), Reputation (Reput)
Qi and Bouguettaya (2013) [43]	Response time (RT), Cost, Latency
Jula et al (2013) [44]	Response time (RT), Cost
Dou et al. (2013) [45]	Cost, Latency, Reputation (Reput)
Karim et al. (2013) [46]	Cost, Response Time (RT), Security (Secur), Reputation (Reput), Availability (Avail), Reliability (Reli), Durability (Dur), Data Control (DC)
Klein, Ishikawa, & Honiden (2014) [24]	Cost
Mostafa & Zhang(2015) [25]	Cost, Reliability (Reli)
G. Fan, Yu, Chen, & Liu (2013) [26]	Response time (RT), Availability (Avail)
A. Singh, Juneja, & Malhotra, (2015) [27]	Cost, Throughput(Thr)
Jula, Othman, & Sundararajan (2015) [28]	Cost , Response time (RT), energy
Kurdi et al. (2015) [29]	Availability (Avail), Reputation (Reput)
Zhao, Shen, Peng, & Zhao(2015) [30]	Response time (RT)
X. Wang, Cao, & Xiang (2015) [31]	Availability (Avail)
Qiang Yu, Chen, & Li (2015) [32]	Cost, Mainntainance(Maint.)
H. Wang, Wang, Hu, Zhang, & Gu (2016) [33]	Reliability (Reli), Durability (Dur)
Gutierrez-Garcia & Sim(2013) [34]	Availability (Avail), Reliability (Reli)
Bastia et al.(2014) [36]	Reliability (Reli),Response time (RT), Throughput(Thr)

The importance notified in addressing QoS parameters is shown in following graph

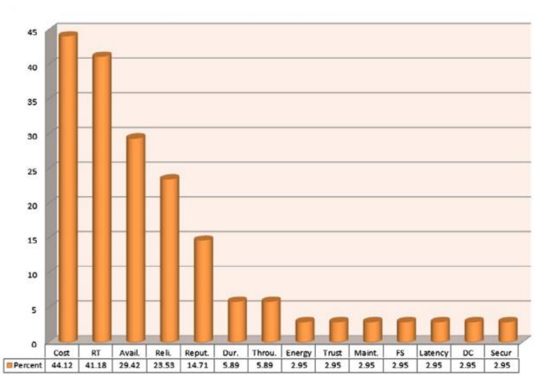

Figure 4. Importance gained by QoS Parameters

The attainment of the questionnaire addressed in the section 2. is represented by following graph.

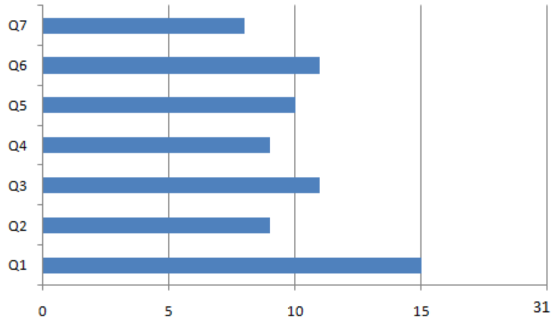

Figure 5. Questionnaire attainment by number of authors

5.1 Research Gap:

1. It has been observed that there is not a single mechanism to address all QoS parameters for composite services. For instance, some mechanisms consider scalability, optimization and combination time while another parameter such as cost, efficiency and etc. was ignored
2. It can be clearly seen that researchers have mainly considered simulator based tools for evaluations. Implementing and studying the behaviour of the discussed approach could be an efficient research direction.
3. Even though the researchers addressed the studies in the context of adaptability of the services due to dynamic changes in cloud environment, there is no research carried on the dynamic service composition in multicloud environment.
4. Service composition mechanisms could be used in other similar environments like peer-to-peer networks, software defined networks, mobile cloud computing.

5.2 Multi-cloud domain

Multi-cloud strategy is the concomitant use of two or more cloud services to minimize the risk of widespread data loss or downtime due to a localized component failure in a cloud computing environment. It improves overall performance of the enterprise. The following are open problem in multi cloud domain

- To develop a service composition mechanism for multi cloud domain that addresses all QoS parameters for the composed services.
- To analyse user requirements and develop a pattern based on the semantic information of the user satisfaction based on previous records for future service composition in multi cloud domain
- To design a QoS adaptive prediction model that can schedule the most appropriate QoS prediction method according to the real-time situation in multi cloud domain.

5. Conclusion

In this paper, the systematic review of the literature related to the cloud service composition is presented with the epigrammatic analysis of various states-of-art mechanisms. The main objective of this work is to identify the research gap in the context of cloud service composition and expose the open research issues in the field of cloud service composition.

References

[1] Ai, L. F., & Tang, M. L. (2008). A penalty-based genetic algorithm for QoS-aware web service composition with inter-service dependencies and conflicts. New York: IEEE.

[2] Hossain, M. S., Hassan, M. M., Al Qurishi, M., & Alghamdi, A. (2012). Resource Allocation for Service Composition in Cloud-based Video Surveillance Platform. New York: IEEE.

[3] Kitchenham, B., & Charters, S. (2007). Guidelines for performing Systematic Literature Reviews in Software Engineering. (2.3 ed., pp. 1–65). Keele University and Durham University.

[4] Kofler, K., ul Haq, I., & Schikuta, E. (2010). User-centric, heuristic optimization of service composition in clouds *Euro-Par 2010-Parallel Processing* (pp. 405-417): Springer.

[5] Pham, T. V., Jamjoom, H., Jordan, K., & Shae, Z.-Y. (2010). A service composition framework for market-oriented high performance computing cloud. In Proceedings of the 19th ACM International Symposium on High Performance Distributed Computing (pp. 284–287). Chicago, Illinois: ACM.

[6] Preve, N. P. (2011). Grid Computing: Towards a Global Interconnected Infrastructure. Springer.

[7] Tzafilkou, K., Protogeros, N., & Koumpis, A. (2015). User-centred cloud service adaptation: an adaptation framework for cloud services to enhance user experience. *International Journal of ComputerIntegrated Manufacturing*(ahead-of-print), 1-11.

[8] Vladimir, K., Budiselić, I., & Srbljić, S. (2015). Consumerized and peer-tutored service composition.*Expert Systems with Applications, 42*(3), 1028-1038.

[9] Walther, S., & Wehrheim, H. (2016). On-the-fly construction of provably correct service compositions– templates and proofs. *Science of Computer Programming*.

[10] Klusch, M., Fries, B., Khalid, M., & Sycara, K. (2005). *Owls-mx: Hybrid owl-s service matchmaking.* Paper presented at the Proceedings of 1st intl. AAAI fall symposium on agents and the Semantic Web

[11] Singh, A. P., Vyas, O., & Varma, S. (2013). A Framework of Service Selection and Composition for Flexible Network Architecture *Quality, Reliability, Security and Robustness in Heterogeneous Networks* (pp. 998-1007): Springer.

[12] Sivasubramanian, S. P., Ilavarasan, E., & Vadivelou, G. (2009). *Dynamic web service composition: Challenges and techniques.* Paper presented at the Intelligent Agent & Multi-Agent Systems, 2009. IAMA 2009. International Conference on.

[13] Soltani, Z., & Navimipour, N. J. (2016). Customer relationship management mechanisms: A systematic review of the state of the art literature and recommendations for future research. *Computers in Human Behavior, 61*, 667-688.

[14] Stanik, A., Koerner, M., & Lymberopoulos, L. (2014). SLA-driven Federated Cloud Networking: Quality of Service for Cloud-based Software Defined Networks. *Procedia Computer Science, 34*, 655-660.

[15] Kofler, K., ul Haq, I., & Schikuta, E. (2009). A parallel branch and bound algorithm for workflow QoS optimization. In Parallel Processing, 2009. ICPP '09. International Conference on (pp. 478–485).

[16] Zeng, C., Guo, X. A., Ou, W. J., & Han, D. (2009). Cloud computing service composition and search based on semantic. In M. G. Jaatun, G. Zhao, & C. Rong (Eds.). Cloud Computing, Proceedings (5931, pp. 290–300). Berlin: Springer-Verlag Berlin

[17] Zhu, Y., Li, W., Luo, J., & Zheng, X. (2012). A novel two-phase approach for QoSaware service composition based on history records. In Service-Oriented Computing and Applications (SOCA), 2012 5th IEEE International Conference on (pp. 1–8).

[18] Lin, W., Dou, W., Luo, X., & Jinjun, C. (2011). A history record-based service optimization method for QoS-aware service composition. In Web Services (ICWS), 2011 IEEE International Conference on (pp. 666–673)

[19] Liu, M., Wang, M. R., Shen, W. M., Luo, N., & Yan, J. W. (2012). A quality of service (QoS)-aware execution plan selection approach for a service composition process. Future Generation Computer Systems-the International Journal of Grid Computing and Escience, 28, 1080–1089

[20] Liu, S., Xiong, G., Zhao, H., Dong, X., & Yao, J. (2012). Service composition execution optimization based on state transition matrix for cloud computing. In Intelligent Control and Automation (WCICA), 2012 10th World Congress on (pp. 4126-4131).

[21] Worm, D., Zivkovic, M., van den Berg, H., & van der Mei, R. (2012). Revenue maximization with quality assurance for composite web services. In ServiceOriented Computing and Applications (SOCA), 2012 5th IEEE International Conference on (pp. 1–9).

[22] Ludwig, S. A. (2012). Clonal selection based genetic algorithm for workflow service selection. In Evolutionary Computation (CEC), 2012 IEEE Congress on (pp. 1–7).

[23] Bao, H. H., & Dou, W. C. (2012). A QoS-aware service selection method for cloud service composition. In 2012 IEEE 26th international parallel and distributed processing symposium workshops & Phd Forum (pp. 2254–2261). New York: IEEE.

[24] Klein, A., Ishikawa, F., & Honiden, S. (2014). SanGA: A self-adaptive network-aware approach to service composition. *Services Computing, IEEE Transactions on, 7*(3), 452-464.

[25] Mostafa, A., & Zhang, M. (2015). Multi-Objective Service Composition in Uncertain Environments.

[26] Fan, G., Yu, H., Chen, L., & Liu, D. (2013). Petri net based techniques for constructing reliable service composition. *Journal of systems and Software, 86*(4), 1089-1106.

[27] Singh, A., Juneja, D., & Malhotra, M. (2015). A novel agent based autonomous and service composition framework for cost optimization of resource provisioning in cloud computing. *Journal of*

King Saud Unive sity - Computer and Information Sciences. doi:http://dx.doi.org/10.1016/j.jksuci.2015.09.001

[28] Jula, A., Othman, Z., & Sundararajan, E. (2015). Imperialist competitive algorithm with PROCLUS classifier for service time optimization in cloud computing service composition. *Expert Systems with Applications, 42*(1), 135-145.

[29] Kurdi, H., Al-Anazi, A., Campbell, C., & Al Faries, A. (2015). A combinatorial optimization algorithm for multiple cloud service composition. *Computers & Electrical Engineering, 42*, 107-113.

[30] Zhao, X., Shen, L., Peng, X., & Zhao, W. (2015). Toward SLA-constrained service composition: An approach based on a fuzzy linguistic preference model and an evolutionary algorithm. *Information Sciences, 316*, 370-396.

[31] Wang, X., Cao, J., & Xiang, Y. (2015). Dynamic cloud service selection using an adaptive learning mechanism in multi-cloud computing. *Journal of systems and Software, 100*, 195-210.

[32] Qiang, D., Yuhong, Y., & Vasilakos, A. V. (2012). A survey on service-oriented network virtualization toward convergence of networking and cloud computing. IEEE Transactions on Network and Service Management, 9, 373–392.

[33] Wang, H., Wang, X., Hu, X., Zhang, X., & Gu, M. (2016). A multi-agent reinforcement learning approach to dynamic service composition. *Information Sciences, 363*, 96-119.

[34] Gutierrez-Garcia, J. O., & Sim, K. M. (2013). Agent-based cloud service composition. *Applied intelligence, 38*(3), 436-464.

[35] Ivanović, D., & Carro, M. (2014). Transforming Service Compositions into Cloud-Friendly Actor Networks *Service-Oriented Computing* (pp. 291-305): Springer.

[36] Bastia, A., Parhi, M., Pattanayak, B., & Patra, M. (2015). Service Composition Using Efficient Multi-agents in Cloud Computing Environment *Intelligent Computing, Communication and Devices* (pp. 357- 370): Springer.

[37] Huo, Y., Zhuang, Y., Gu, J., Ni, S., & Xue, Y. (2015). Discrete gbest-guided artificial bee colony algorithm for cloud service composition. *Applied intelligence, 42*(4), 661-678.

[38] Kholidy, H. A., Hassan, H., Sarhan, A. M., Erradi, A., & Abdelwahed, S. (2015). QoS Optimization for Cloud Service Composition Based on Economic Model *Internet of Things. User-Centric IoT* (pp. 355-366): Springer.

[39] Karimi, M. B., Isazadeh, A., & Rahmani, A. M. (2016). QoS-aware service composition in cloud computing using data mining techniques and genetic algorithm. *The Journal of Supercomputing*, 1-29.

[40] Huang, B., Li, C., & Tao, F. (2014). A chaos control optimal algorithm for QoS-based service composition selection in cloud manufacturing system. *Enterprise Information Systems, 8*(4), 445-463.

[41] Lartigau, J., Xu, X., Nie, L., & Zhan, D. (2015). Cloud manufacturing service composition based on QoS with geo-perspective transportation using an improved Artificial Bee Colony optimisation algorithm. *International Journal of Production Research*(ahead-of-print), 1-25.

[42] Zhang, H., Guo, R. F., & Geng, C. (2014). *Hierarchical Optimization Model of Cloud Manufacturing Services Combination.* Paper presented at the Applied Mechanics and Materials.

[43] Qi, Y., & Bouguettaya, A. (2013). Efficient service skyline computation for composite service selection. IEEE Transactions on Knowledge and Data Engineering, 25, 776–789.

[44] Jula, A., Othman, Z., & Sundararajan, E. (2013). A hybrid imperialist competitivegravitational attraction search algorithm to optimize cloud service composition. In Memetic Computing (MC), 2013 IEEE Workshop on (pp. 37–43)

[45] Dou, W., Zhang, X., Liu, J., & Chen, J. (2013). HireSome-II: Towards privacy-aware cross-cloud service composition for big data applications. IEEE Transactions on Parallel and Distributed Systems.

[46] Karim, R., Chen, D., & Miri, A. (2013). An end-to-end QoS mapping approach for cloud service selection. In Services (SERVICES), 203 IEEE Ninth World Congress on (pp. 341–348)