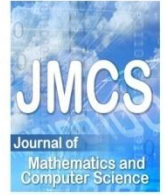


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## **A New Method on Service Oriented Architecture Governance Maturity**

**Assessment :**

### **A Case Study on Telecommunication Company of Iran**

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#### ***Abstract***

The concept of Service-Oriented Architecture Governance (SOAG) has emerged as a way to implement control mechanisms in a service oriented architecture SOA.IT and specially SOA, have created opportunities to improve the business needs. Organizations without a strong government may not benefit from a service-oriented architecture. SOAG Plays an important role in SOA success , acceptance maturity model and organization strategic goals and plannings and where is the organization today in terms of our business or strategy planning and where it wants to go. Assessing SOA governance maturity level in the organization can assist with the successful implementation of SOA. The main purpose of this paper is to provide a method for assessing the SOAG maturity level. By applying the following assessment model, organizations can identify their strengths and weaknesses areas for improvement and thus enhance their readiness. For instance this paper has applied this framework to a real case study, a Telecommunication Service provider in Iran and the results to show excellence compared with other method.

**Keywords:** Service-Oriented Architecture, Service-Oriented Architecture Governance, fuzzy.

## **1. Introduction**

The field of Service-Oriented Architecture (SOA) has received much attention in the past years [22]. Besides introducing new technologies and responsibilities, SOA requires a change from

application-based thinking to an enterprise-wide perspective intended to control how workflows are accomplished and how services and a portfolio of services are developed, deployed and managed throughout their lifecycle to accomplish enterprise business objectives[12].Governance is a key factor in the success of the Service-oriented architecture in organizations[20].Tilak Mitra [24] is one of the first to scholars who considered governance issues in relation to SOA. He claimed that by embracing SOA, governance needs to be taken more seriously into account because of the distributed nature of services across lines-of-business.In general, governance is means of establishing and enforcing how people and solutions work together to achieve organizational objectives.SOAG ensures continued alignment of business goals and SOA solutions. It covers the definitions of standards, guidelines, policies, and metrics for current SOA processes which are monitored with compliance processes[14]. Establishing SOAG should also be seen as providing another opportunity to bridge any gaps between enterprise and IT governance. SOAG would benefit from existing IT and Enterprise governance[18] Effective SOAG requires equal focus on the people, process, and technology; therefore, defining and scoping SOAG can be a challenge [11].Without understanding the current position of the organization, a map will not help [18].The maturity level of an organization provides a way to predict the future performance of an organization within a given disciplines, moreover, it helps to identify gaps and prioritizing areas in need of development, improvement or enhancement. The first step in achieving Governance maturity is assessing and measuring the organizations current status in each governance.

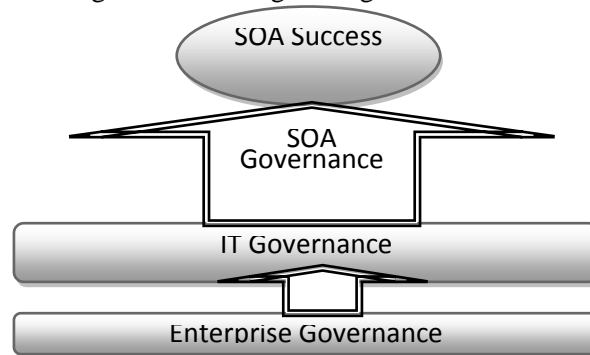


Figure 1 . SOA Governance overview

This article provides a new effective method to solve problems in determining the current maturity level of organization's SOAG. this article is structured as follows: Section 2 presents a review of previous research studies.Section 3 provides an overview of the methodology used in this research work.Many factors affect SOA success.A number of these factors will be explored in this section.Finally,Section4 proposes a model using fuzzy logic for one of the Iranian Telecommunication organizations. Moreover, Section 4 presents the result of statistical analyses and compares them to those reported previously.

### 3. Related Work

Scheper and Kratz proposed a model for SOA governance maturity [5].They identify three levels based on six levels of maturity:empowerment and preparation of technology,empowerment and preparation of SOA, business services of SOA, life cycle management, SOA adaption and optimization of SOA. Scheper model presents SOA maturity levels for business domain.Marks[8]presents SOA governance maturity model in five levels: little to no governance, informal governance, explicit governance, collaborative governance and optimized governance .It's focused on SOAG maturity levels.consider in SOA maturity levels and SOA adoption domains is low.The other model[5] introduce four levels for SOA governance and try to increase maturity of SOA governance.This model develop SOAG life cycle with transition to steps of SOA life cycle. Control objectives for information and related technology (COBIT)[25] maturity model focused on policies, processes, organization and

infrastructures maturity. COBIT provides an information technology maturity model that is derived from the CMM. This model considers six levels such as: non-existence, initial/non-public and specific, repetitive but intuitional, defined, measurable and managed process optimized[9]. In WebMethods framework[16] the service lifecycle consists of three phases: design, implementation and changes, and policy, have been made based on the information technology. Governance architecture is the main issue in the context of governance. IBM framework[15] includes four main processes in governance. These processes help the organization to create alignment between business and information technology. These processes are: The process of keeping and maintaining SOA, the SOA definition, the process of communication and the process of implementing Service-Oriented Architecture. Oracle approach[12] is defined based on the maturity of service-oriented organization and the Capability Maturity Model Integration, and is a gradual process which identifies the 6 step paths. This framework focuses on different areas of policy and governance, and the roles and responsibilities as one of the main components of the rule has been less attention. Namdarian and et proposed a framework to evaluate SOA governance (SOAG)[10]. The framework have Three dimensions: SOA maturity levels, SOA governance maturity levels and SOA adoption domains. Namdarian framework is more comprehensive than the previous models. In this framework, SOA governance consider the organizations SOA maturity and this shows better view of SOAG in the organization. Through this framework, organization can recognize its current situation better and determine its future status easier. The next part is review of maturity assessment methods that see them in table 1:

Table 1 . SOA maturity assessment methods

Reference	Assessment method	Weakness
(Abdul Manan 2013)[6]	Develop and validate critical success factors (CSF) framework then used scored method. experts and IT practitioners groups scored CSFs in 5 likert scale. the participants also responses weakness or strength of CSFs. Final output is average scores for CSFs in every dimentios.	Only by get the average of experts opinion that is not enough accuracy and reliability
(Javanbakht 2009)[19]	sledom ecnerefer gnisU dna by giving points to each component of matrices( task –applications and...) Find total score by scores achieved in each layer. With the final score compare quantitative of components is possible.	Long path to reach the answer Use of many matrices
(Mahmoudi 2010)[4]	Introduction of framework by four domains and indicators for assess the maturity. In assessing the maturity levels uses weighted average and use IT processes as an indicator	Average is weak method and it is not Strong inference approach
(Razmi 2009)[17]	Main areas dna critical success factors for ERP implementation are evaluated and the assessment factors are determined. The algorithm of fuzzy analytic network process is then used to determine the level of a firm's readiness to implement an ERP system	ANP used When between variables are many interacting and it express feedback between them. It use more in Multi Criteria Decision Making because the factors impact on each other. Additionally matrix is time-consuming

(Curt Amo 2007)[13]	Some questions that 3 teams (CIO, the core enterprise architecture and the core team of peers) response them.Average score for each group and average for the overall assessment, was considered to calculate.	Only by get the average of experts opinion that is not enough accuracy and reliability
(Julian Eckert 2010)[3]	Using TOP-VIEW(technical,organization and procedural )Which is based on CMMI maturity model. Fields are shown with “+,-,0”.positive (+) means that the current level is obtained (0) means that this level yet because they are still developing.negative (-) means that the level of maturity not possibly be achieved in the short term	Is not full and comprehensive. method is not accurate .
(Namdarian 2011)[2]	The binomial test was used to test the hypothesis that this work was performed with spss software	Statistics examines only one type of uncertainty and the degree of accuracy is very low.

Most common methods are used of statistical analysis and regression techniques. This techniques presented with an error and could not acceptable precision and accuracy also the maturity indicators ,do not interact wih together.Access to decision-makers and experts in an organization is difficult so use of fuzzy preferred.Design models using fuzzy is evident from the strong support by mathematics that is The proof of the reliability of fuzzy systems. Fuzzy sets can improve results,precise assessment and efficient assessment processes also translate human language to semi-mathematic algorithms.Considering the options and features of the fuzzy in accuracy use of this method is superior.

### 3.Research methodology

The methodology used in this study is as follows:

#### 3.1.Select framework

The assessment framework is composed of four levels:weak, medium, good andvery good.Each level shows maturity level organization. The assessment framework contains three dimention(service-oriented architecture maturity levels, levels of architecture and service-oriented architecture) and 17 sub-dimention .Each dimesnion has a scale and ranges from 0 to 10.Moreove,the maturity level can be identified on the framework

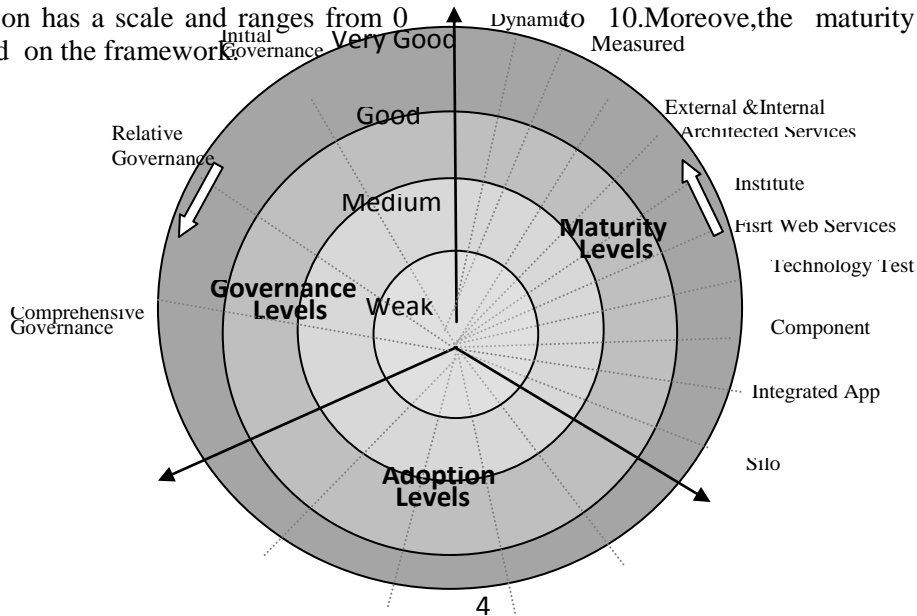




Figure. 2. Conceptual framework to evaluate SOA governance

Dimensions is chosen based on the Namdarian framework Because it provides more complete and comprehensive in field of service-oriented governance maturity except in SOA maturity dimension. There are many framework in SOA maturity .The SIMM is based on several references (Arsanjani & Holley 2005, Arsanjani 2005, Meehan 2006, Arsanjani 2002, Falkl 2005, Duermeyer 2005)which consists of seven maturity levels presented in the left part of table 2.The SOA Maturity Model was published in October 2005 by four vendors of SOA solutions: Sonic Software Inc., Bearingpoint, Systinet and AmberPoint.It consists of 5 maturity levels, as shown in table 2. Namdarian use SOAMM but we use CSOAMM as an alternative. CSOAMM is a model with 10 levels that describes SOA maturity by combining level characteristics of two recently published maturity models: SIMM and SOAMM[21].

Table 2. Combined SOA Maturity Model – CSOAMM [21]

SIMM	CSOAMM	SOAMM
7.Dynamically reconfigurable services	7.Dynamically reconfigurable services	5.Optimized Business Services
6.Virtualized Services	6.Measured Services	4. Measured Business Services
5.Composite Services	5.Internal and external Services	3a. Business Services 3b.Collaborative Services
	4.Architected Services	2. Architected Services
4.Simple Services	3.Institutionalisation	
	2.First Published ws	1.Initial
3.Componentized	1.Technology Test	
	0.Components	
2-Integrated	-1-Integrated	
1-Silo	-2-Silo	

### 3.2. Identify critical factors

After selecting the model, need to assess factors. Models composed of 3 dimensions, 17 factors and 101 sub-factors , which can be view at table 3.

Table 3. Measures of SOA maturity levels ,SOA governance maturity levels and SOA adoption domain

Main Dimen	Sub-Dimension	Nu mbe	Sub Indicators
------------	---------------	--------	----------------

tions	(indicators)	r	
SOA Adoption Domains	Intra-Department	1	Individual departments have a service oriented.
		2	Development projects as ideas are few
		3	engage in business with little or no interaction at all.
		4	stakeholders has been issued a permit by rule yet Vtlashhay there is little to establish SOA
	Inter-Department	1	Various departments of a business unit are empowered to adopt SOA architecture using service to interact with each other.
		2	begins Permission from stakeholders and the use of SOA governance
	Inter-Business	1	A firm step in the direction of enterprise SOA enablement is the interaction of services across business units
		2	Service reuse is maximized at this point
		3	A firmly established governance module institutes policies, processes and standards to be followed while creating new services
		4	A service repository ensures maximum service reuse
		5	Regular Business Activity Monitoring ensures the optimal functioning of services
	Enterprise	1	uses of optimal services of Institute that are configured dynamically based on timely data,

This table demonstrate the measures of each of the three dimensions of the proposed framework in detail. First part is SOA adoption that contain 4 factors. second part is SOA maturity that used CSOAMM maturity model.

Main Dimensions	Sub-Dimension (indicators)	Number	Sub Indicators
SOA Maturity	Silo	1	data are Integrated
		2	High processing power systems and low variability
		3	There is integration
	Integrated Application	1	There are plans to integrate
		2	EAI enterprise application integration organization
		3	Data flow is balanced and guidance
		4	The layered architecture has been used.
		5	Point-to-point communication.
	Components	1	In terms of functional modules have appeared.
		2	have integrated functionality.
		3	components and services are identified.
	Technology Tests	1	Changes in organizational culture started to develop SOA
		2	There are lab projects in an organization.
		3	Skills are taught to develop the service.
		4	conversion of legacy systems as services .
	First published Web Services	1	first Web services are produced.
		2	The attitude of the organization's information technology based service-oriented.
		3	Standard case protocols
		4	Work processes are associated with the service
		5	processes are integrated
		6	conversion of point to point communication connection based on service description
		7	Use the Service Bus
		8	There reservoir storage services and policies
	Institutionalized	1	Professional services and functionality are integrated.
		2	Service Oriented Architecture have a team and a leader
		3	SOA integration and development process in the organization
		4	Support for heterogeneous distributed systems
		5	Reduce IT costs and ease of control and monitoring system
	Architected Services	1	Monitor the service by definition and policy
		2	Implementation of architectural services
		3	changes in the level of information technology
	External And Internal Services	1	integration of the production chain
2		Connection between business processes and services	
3		Connection between business processes and services	
4		Establishing contracts and communications between services by demands	
5		changes the information technology in the enterprise	
6		Full support of business processes	
7		Develop business processes based on service- oriented for foreign organizations	
8		establish policy to create and modify the professional processes based on service-oriented	

		9	Orchestration Service to manage long running processes
		10	Communication with internal services and external services
		11	establish policy to Professional and business partners for cooperation
		12	Extend business processes to external organisations
		13	Implement cross enterprise security
	Measured Services	1	Converter professional affective states in real time scenarios
		2	Define standards of professional performance
		3	Measuring real-time performance
		4	Monitoring business activity
		5	Separation services and programs
		6	Independence of Technology
		7	virtual infrastructure
		8	completely dynamic Infrastructure
		9	Existence of separate services to manage, monitor and respond to events
	Dynamic Architecture Compose services	1	integrating ecosystem
		2	Automate Business processes
		3	implemented career corrections Processes
		4	event based Automated
		5	Response to events based on predefined rules for optimal of professional goals
		6	Combination of services and applications at runtime
		7	Automated reconfigurable architecture
		8	Despite a sense of meaning and answers

Third part is governance. It is to make sure services are a certain level of quality and follow the policies by company[1]. It contains 3 factors.

Main Dimensions	Sub-Dimension (indicators)	Number	Sub Indicators
SOA Governance Maturity	Initial Governance	1	There is a small and informal governance
		2	Governance is " bottom-up " and for key areas such as architecture and design firm servicing done.
		3	There are partial cooperation among key stakeholders
		4	Governance model and processes and policies is not clearly
		5	A teamwork model suggest that although it does not formally organized
		6	Key processes are well done , but other processes are not well defined and managed
		7	The emphasis is on the key relationships between people . There is no alignment between IT and business
		8	Governance does not address
		9	Property is obvious , but their roles have not been defined clearly illuminated .
	Relative Governance	1	Governance is clear and collaborative
		2	Governance is the "bottom-up" mode to the "top-down" and then becomes a collaborative model.
		3	Governance is a policy-oriented and policies to be clear
		4	There is alignment between the policies and goals of the organization.
		5	The emphasis is on accountability, participation and control
		6	Ownership is clear
		7	The emphasis is on improving and strengthening
		8	The emphasis is on accountability for all key processes government
		9	The execution and performance of the institution's governance and participatory decision-making is emphasized.
	Comprehensive Governance	1	Understanding government is fully recognized
		2	Everywhere there is government, and some government Committees are excluded
		3	Governance is particularly prevalent
		4	Organization to move the policy norms and normative behavior
		5	The most basic approach is to transform government institutions
		6	Through government , practices and incentives are aligned



		7	Government is the culture of the institution
		8	Government evolves and aligned with business priorities .

### 5. 3.3. Evaluation

Collect data from qualitative questionnaires.used seven scales linguistic variables (Table 4):

Table 4.Fuzzy Linguistic Variable

Linguistic variable	Fuzzy number	Fuzzy scale
Very woL	0.05	(0,0,0.1)
woL	0.1	(0,0.1,0.25)
woL muideM	0.3	(0.15,0.3,0.45)
muideM	0.5	(0.35,0.5,0.65)
hgiH muideM	0.7	(0.55,0.7,0.85)
High	0.9	(0.75,0.9,1)
Very High	0.95	(0.9,0.9,1)

Population,was professional in organizations and companies that want to measure its maturity level.In case study distributed 50 questionnaires that 32 questionnaires were completed and used.

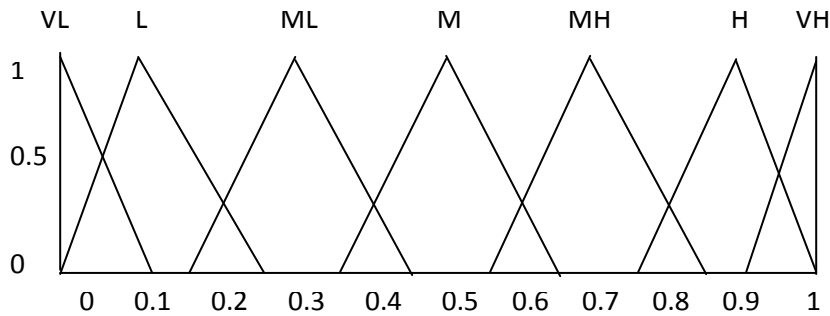


Figure 3. Membership function for bases 1-20 entrances

For evaluation used fuzzy logic.Fuzzy measure is extension of probability measure. Fuzziness as used in fuzzy logic is about kind of uncertainty and vagueness especially the uncertainty of linguistic terms and distinguishes from the uncertainty offered by probability theory[10]. The main reason of using this theory is representing data that have ambiguous. Also in this method we can use mathematical operators as well as crisp sets[9].Fuzzy set ( very low to very high,) define with triangular membership functions.At first , gather information from experts and managers through questionnaires, and then analyze and evaluate information on the use of fuzzy logic. Mamdani fuzzy logic is used for proposing this model.

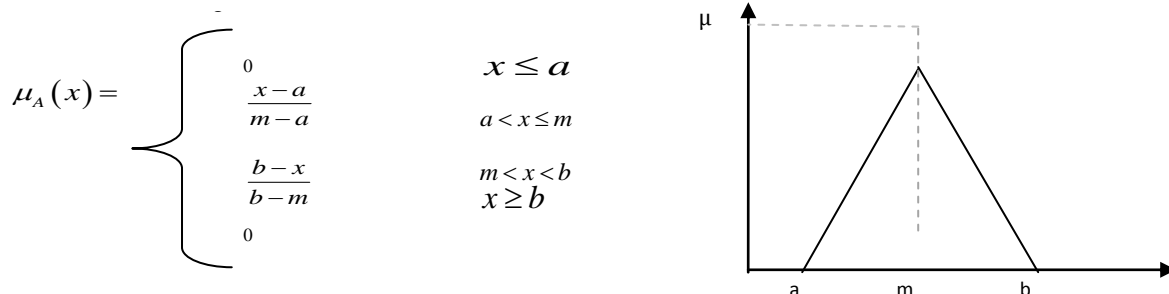




Figure 4 .triangular membership function

In second stage, it is necessary define the basic rules that are the heart of the fuzzy system. These rules reflect the reality of how the relationship between fuzzy sets defined in the fuzzy inference system together and how they influence the final output. Creating a fuzzy rule base system using rules editor and as if - then it is done. See rule form below:

IF  $x_1$  is  $A_{i1}$  and  $x_2$  is  $A_{i2}$  .... and  $x_s$  is  $A_{is}$  THEN  $y_i = z_i(x)$ ,

where  $x=(x_1, x_2, \dots, x_s) \in U_1 \times U_2 \times \dots \times U_s$  are linguistic variables,  $A_{ij}$  are fuzzy sets of the universes of discourse  $U_j \in R$  ( $j=1, 2, \dots, s$ ),  $R_i$  represents the  $i$ th rule,  $i=1, 2, \dots, p$ , and  $y_i \in V$  is the output of the  $i$ th rule.

According to Mamdani principles, the fuzzy inference process follows “min-max” inference and forward chain inference algorithm. Min is used for “and” operator and max is used for “or” operator. The “and” operator is used for implication and “max” operator for aggregation.

$$\mu_{A \cup B}(X) = \max[\mu_A(X), \mu_B(X)]$$

$$\mu_{A \cap B}(X) = \min[\mu_A(X), \mu_B(X)]$$

At the end fuzzy numbers must be transformed into crisp real numbers. There are many methods have been developed for this purpose such as centroid, center of sums, mean of max. This paper used centroid method (COA). See formula 1.  $Z_{COA}$  is Certain value of the output and  $\mu_c(z)$  is output Membership function .

#### 4. Case study

We implemented the proposed method on Sari Telecommunication to assess its readiness level. Sizes of the fuzzy system were assessed by questionnaire. After verification, questionnaire was distributed among high and middle managers. Each managers response to each questions in the questionnaire.

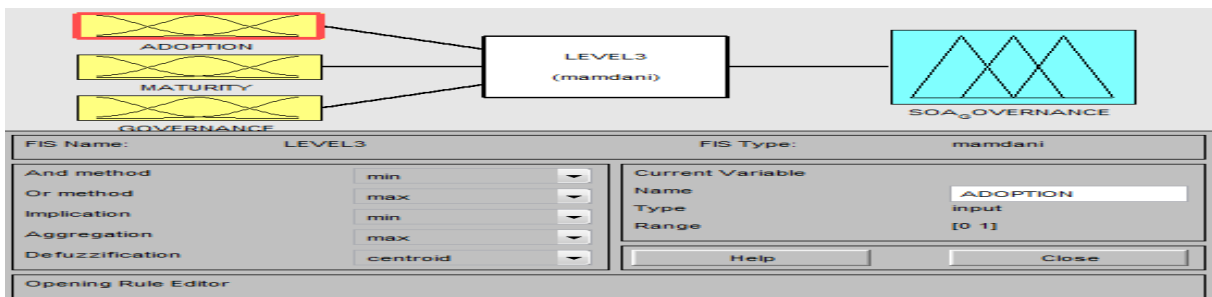


Figure 5. The Fuzzy system of assessing the Maturity level of the Organization in MATLAB software

The triangular fuzzy average was calculated for each answer. This average reflects the opinion of a manager to a questionnaire. Finally, average of comments about each criterion was calculated for all managers. Thus, for each criterion, is obtained numerically to indicate that managers. To design a comprehensive system of inference rules, will establish a base for every model dimensions then output of every dimensions, will entires for next level of systems (figure 5). There are 21 rule bases in the case study database. 17 bases to assess the first entry-level indicator that their output are related to entry 2 Level and output level 2 related to entry level 3. base 21 is the major rule base have three main indicators and its output value is the end of the maturity level of governance in the organization. Mamdani method used for this so Linguistic rules is :  $R_i$  : IF  $x_1$  is  $A_{i1}$  and...and  $x_r$  is  $A_{ir}$  THEN  $y$  is  $C_i$  And input form is  $x_1$  is  $A'_{1}$ ,  $x_2$  is  $A'_{2}$ , ...,  $x_r$  is  $A'_r$

$$\mu_{c^i}(y) = (a_{i1} \wedge a_{i2} \wedge \dots \wedge a_{in}) \wedge \mu_{ci}(y)$$

$$\alpha_{ij} = \sup_{x_j} (\mu_{A_j}(x_j) \wedge \mu_{A_{ij}}(x_j))$$

Aggregation of outputs from all rules is  $\mu_c(y) = \max\{\mu_{c^1}(y), \mu_{c^2}(y), \dots, \mu_{c^3}(y)\}$  so example of some result fuzzy rule bases are:

*IF(adoption is inter-dep)and(maturityis tech)and(governance is initial)then(soa\_governance is medium)*

*IF(adoption is inter-dep)and(maturityis serv)and(governance is initial)then(soa\_governance is medium)*

*IF(adoption is intra-dep)and(maturityis comp)and(governance is initial)then(soa\_governance is weak)*

*IF(adoption is intra-dep)and(maturityis silo)and(governance is initial)then(soa\_governance is weak)*

At the end output must be defuzzy with formula 1.

Can see outputs obtained from the fuzzy system in radar chart in figures 6.7

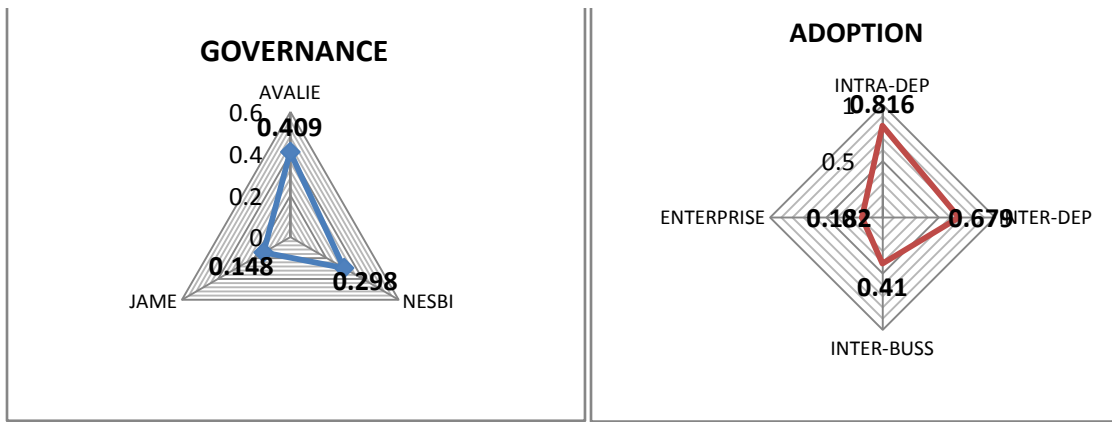


Figure 6.a. Radar chart for SOA Governance

Figure 6.b. AOS rof trahc radaR Adoption

As see the adptation field with a value of 0.452 is the highest level of service-oriented architecture.

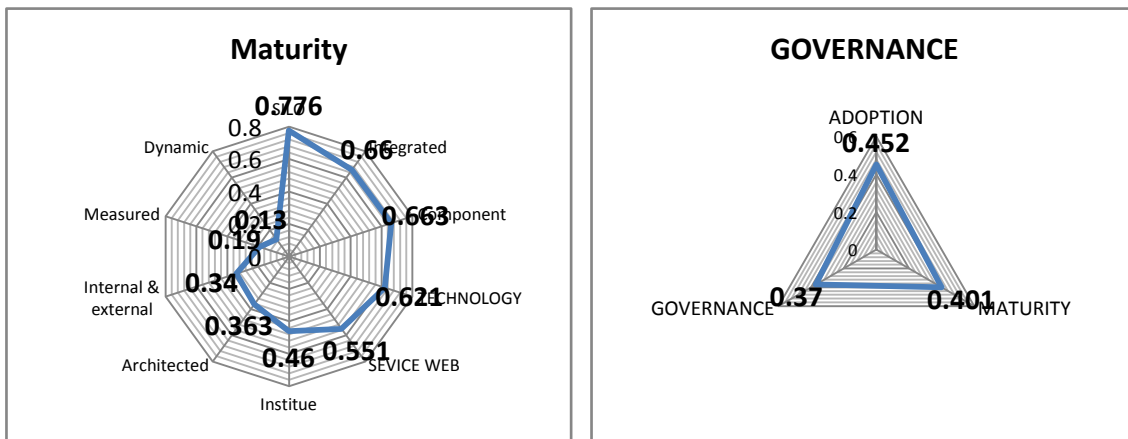


Fig 7.a. daRarof trahc r Maturity

Fig 7.b. rof trahc radaR Enterprise Governance

For comparison, distributed the other questionnaires for binomial test (sign-level = 0.05, cutpoint = 1). For this purpose, at each level and for each factor consider two states:

$H_0$  = The organization has this factors.

$H_1$  = The organization has not this factors.

Figure 8. shows binomial test in interbusiness level.

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
interbusin1	Group 1	1.00	22	.69	.50	.050
	Group 2	2.00	10	.31		
	Total		32	1.00		
interbusin2	Group 1	1.00	12	.38	.50	.215
	Group 2	2.00	20	.63		
	Total		32	1.00		
interbusin3	Group 1	1.00	9	.28	.50	.020
	Group 2	2.00	23	.72		
	Total		32	1.00		
interbusin4	Group 1	1.00	24	.75	.50	.007
	Group 2	2.00	8	.25		
	Total		32	1.00		
interbusin5	Group 1	1.00	12	.38	.50	.215
	Group 2	2.00	20	.63		
	Total		32	1.00		

Figure 8. Example of Binomial Test

SPSS software was used for statistical analysis. Based on the observations made from the output of the binomial test. The results can be seen in figure 9.

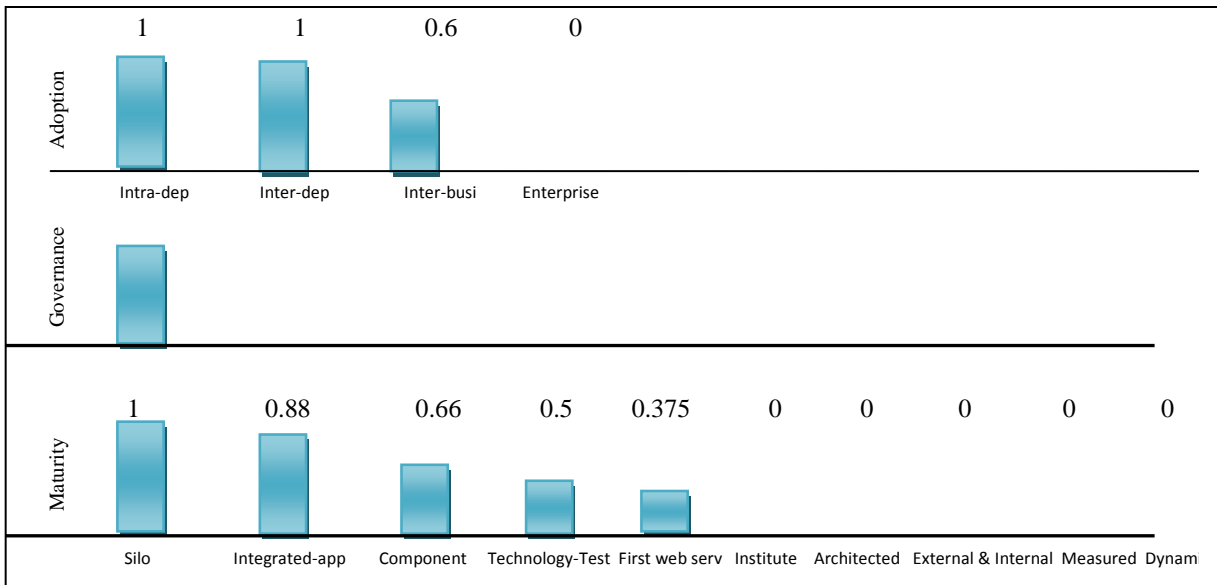


Figure 9. Binomial Test in SOA Dimensions

## 5. Discussion

According to the output of the fuzzy and membership functions in the interdepartment level, most of the indicators have been in the interbusiness level. Those indicators that have not been in the interbusiness level are, in fact, moving toward this level and get some features of interbusiness level. However, the enterprise level has a very low ability. Obtain value of 0.401 for service-oriented maturity dimension that is almost complete in technology level and is moving towards first web services. Most organizations are below this level, and have tried to achieve this level of

organization. In dimension of Service-oriented architecture governance value 0.37 obtain that is crossing primary level and entry to relative governance level. According to the value of 0.425 for the entire organization, we can conclude, service oriented governance is the medium level of and is moving towards good level. Therefore, to achieve the highest level try to find ways to increase the weaknesses that hit them on the radar charts for more performance and service-oriented. In comparison fuzzy system with the data obtained of statistics method can see Statistical method to show the exact amount of either feature is disabled but fuzzy show the percentage of each individual's fitness level of preparedness Statistical. For example to show maturity level of the relative governance and comprehensive governance, value 0 but the actual value of the fuzzy system can be observed. Precision differences is obvious in the evaluation of fuzzy and statistical method. In statistical method to obtain the exact value of maturity at a level not possible. But can determine the maturity level with a number in fuzzy method.

## 6. Conclusion and future research

This paper proposed new methodology for evaluation of the service-oriented governance maturity level for a telecommunication company in Iran. This article used a framework for evaluation of SOA maturity in this organization. The framework is composed of four level: weak, medium, good and very good. Each level shows maturity level of SOA depending on where the organization is on its SOA journey.. the proposed framework contains three dimensions (service-oriented architecture maturity levels, levels of governance maturity of service-oriented architecture and service-oriented architecture) and 17 sub-dimensions.

In this regards, this study used fuzzy logic to determine the organization's maturity level and evaluate the SOA implementation readiness of organization. However for the sake of completeness, the binomial test is applied to obtain the maturity level of the organization. According to the results by two methods, it can be concluded that the fuzzy logic provides more accurate results. That being said, the fuzzy logic approach, provides a precise maturity level. In this regards, this proposed framework can help organizations to identify their strengths and weaknesses and hence, improve their performance and competitive advantage. This research study suggests the combination of fuzzy logic with neural networks for future research studies. The measuring method can use fuzzy clustering method to classify more appropriate and reasonable criteria.

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