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Empirical Analysis of Function Points in Service Oriented Architecture (SOA) Applications

Khalid Mahmood,
Institute of Computing and Information Technology,
Gomal University, Pakistan
Khalid_icit@hotmail.com

M. Manzoor Ilahi
Comsats Institute of Information Technology
Islamabad, Pakistan
tamimy@comsats.edu.pk

Bashir Ahmad
Institute of Computing and Information Technology,
Gomal University, Pakistan
bashahmad@gmail.com

Shakeel Ahmad,
Institute of Computing and Information Technology,
D.I.Khan, Pakistan
Shakeel_1965@yahoo.com

Abstract:
Service Oriented Architecture (SOA) is an emerging area of software engineering, based on the concept of "re-usable services" to support the development of rapid, economical and stable distributed application even in heterogeneous environments. Function point is considered an accurate and well established approach among its competitors to estimate the efforts, size and functionality of software development projects. Estimating the cost, size and efforts for SOA application is a difficult task due to its diverse nature and loose coupling behavior, which results in an inaccurate estimate to measure the efforts, size and functionality of SOA applications. This research paper explores the shortcomings of function point estimation technique and suggests calibration in its value adjustment factor to properly map the characteristics of SOA applications. A Work flow model is proposed to estimate the efforts and functionality of SOA application to consider the Service development efforts as well as Service Integration efforts. Empirical Results shows considerable improvements in estimation process to reduce the error percentage in performance measures like Magnitude of relative error, Mean Magnitude of relative error and Root Mean Square Error.

Key Words: Service Oriented Architecture (SOA), Integration Efforts, Efforts Estimation, Function Point Analysis,

1. Introduction:

"Service Oriented Computing (SOC)" (Michael 2006) is a contemporary software engineering paradigm, construct on the notion of "service-logic" through which a kind of software development can be reached which is fast, low cost, and rapid, economical and up to the mark even in diverse environments. "Service Oriented Architecture (SOA)" is based on "service" logic, where the components come together to form a group of services, which are "loosely coupled" that fulfills the purpose and caters for the requirement of user and business process. SOA applications are able to assist

all kinds of business applications and agile processes particularly in the domain of web services, sanitation, executive institutions of a country, education and on demand business.

1.2. Service

"A service is an implementation of a well defined piece of business functionality, which is discoverable through published interface and used by service consumers when building different applications and business process" (Zdravko 2009).

1.3. SOA Entities and Characteristics

"Service Oriented Architecture" is an architectural paradigm that incorporates a structure of coordination among the major functional components, where the "service consumer" interacts with "service provider" to locate a service which matches it requirement by a process of exploring for "service registry".

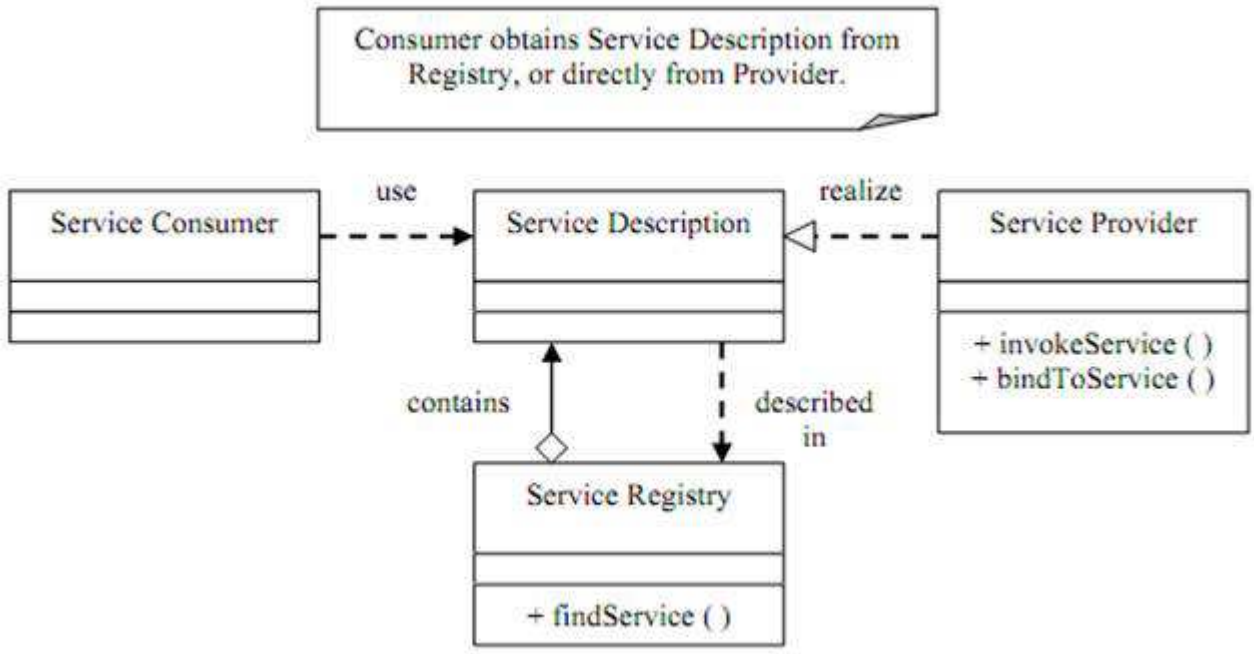

Figure 1.1 Service Oriented Architecture Entities Conceptual Model (James 2003)

"Service Oriented Architecture" lies down some particular rules and features the application of which is mandatory for development of service oriented architecture applications (Bieber 2001).

- Services are self discoverable and dynamically bound
- Services are self contained and modular
- Services are loosely coupled.
- Services are contractual.
- Services are stateless.
- Services are interoperable.
- Services have network addressable interface.
- Services are coarse grained.
- Services are autonomous.
- Services are reusable entities.
- Services are abstract.

2. Effort estimation techniques

"The National Estimating Society (Boehm 1998) has defined Cost Estimating as: The art of approximating the probable cost of something based on information available at the time".

2.1 Function Point Analysis (FPA)

Initially function point counting method consist of four basic components and ten "general system characteristics", in 1983 modification to function point to increase the basic components to five with the total of fourteen "general system characteristics" instead of ten. In 1984 (ifpug 1999) an organization namely "International Function Point User Group (IFPUG)" was established to uniform the counting standards and advancement in the function points. A number of variations to the actual function points have been made by some practitioners and Mark-II function points majorly used in Britain, 3D functions points developed by Boeing, COSMIC full function points, De-marco function points and feature function points have been developed (David 2006). But function points developed by Albrecht are used today and according to "International Software Bench Mark Standards Group" (ISBSG) completed project database almost 90% projects are measured through function points (Christopher 2005). In function point analysis fourteen General System Characteristics (GSCs) are used to construct a Value adjustment factor (VAF) with which the basic function point is adjusted. Although the GSC and VAF are criticized on both theoretical as well as practical grounds but they are used by many practitioners (Zdravko 2009). Author suggests that for SOA environment some GSCs need modifications to truly describe the SOA projects as well as inclusion of new characteristics such as Integration efforts to provide accurate estimates.

3. Empirical Analysis of Function Points in SOA:

As SOA is implemented mostly by the concept of web services (Francisco 2001), and web services have special characteristics. Function point estimation method was developed almost 31 years ago. Due to technological and methodological advancement many new approaches have been introduced which has changed the nature of software development. Though Function Point is adjusted with most of these changes but recent software specifications do not perfectly meet FP metrics. Function points weight system and its general system characteristics are mostly the same, so it needs modification (Abdullah 2005) as well as to solve integration issue inclusion of new characteristic namely "Service Integration Efforts", as SOA architecture is composed of a mesh of web services. The table listed below describes the proposed GSC which should be modified.

Table 3.1 Proposed General System Characteristics

S.No.	General System Characteristics	Description	Modification Needed: Yes Not needed: No
GSC1	Data communications	In SOA communication b/w services is not done through RPC, but SOA supports a number of protocols such as UDDI, XML, SOAP, JSON used for communication	Yes
GSC 2	Distributed data processing	In SOA services are distributed but controlled centrally through service registry	Yes
GSC 3	Performance	Performance measured in terms of resource utilization, error handling and process optimization	Yes
GSC 4.	Heavily used configuration	Measurement in terms of Software/Hardware Implementation	Yes
GSC 5	Transaction rate	How frequently are transactions executed daily, weekly, monthly, etc.?	No
GSC 6	On-Line data entry	What percentage of the information is entered On-Line?	No
GSC 7	End-user efficiency	Was the application designed for end-user efficiency?	No
GSC 8	On-Line update	How many ILF's are updated by On-Line transaction?	No
GSC 9	Complex processing	Does the application have extensive logical or mathematical processing?	No
GSC 10	Reusability	Was the application developed to meet one or many user's needs?	No
GSC11	Installation ease	How difficult is conversion and installation?	No
GSC 12	Operational ease	How effective and/or automated are start-up, back up, and recovery procedures?	
GSC 13	Multiple sites	In SOA services are developed to be accessed by a number of users at various sites. Instances of single application accessed at various locations at same time.	No
GSC 14	Facilitate change	Was the application specifically designed, developed, and supported to facilitate change?	No

GSC 15	Integration Services	Whether the application needs other services to be integrated to perform its functions	Newly added Characteristics

4. IMPLEMENTATION

In order to perform the empirical analysis of function points in service oriented architecture applications, and to verify and authenticate the Proposed Work Flow Model three case studies are selected. First Case study describes the Course Registration System, secondly describes the Online Resume Bank (ORB) and the third selected case study is Online Banking System. These above cited case studies are developed by two teams of ICIT students as a final project for the fulfillment of their Bachelor degree in Computer Science. In order to estimate efforts one team has estimated it through function point estimation technique, where as the second team has estimated the efforts through proposed modified function point estimation. All these projects are built on the concept of Service Oriented Architecture using XML and ASP.Net as a source code languages. Description of the case studies is provided below. Results are evaluated first empirically through Magnitude of Relative error, Root Mean Square Error and statistically through Correlation and Regression Analysis. Results are discussed in the next chapter.

4.1 Case study 1: Online Resume Bank

Online Resume Bank (ORB) provides a set of services to its users interested in applying for a number of jobs offered by a particular organization. User Register itself through signup service. Resume Builder service offers an easy way to build user profile, Online Job Application service is provided to apply for the published jobs by the system. Current status of the application and application tracking facility is provided. Short listed candidates can print the interview call letter, and other relevant information through this system. This software application is developed on the concept of service oriented architecture frame work by using ASP.Net, XML and Microsoft SQL Server as the programming language tool.

4.2 Case Study 2: Course Registration System

Course Registration System provides services to students, professors and registrars. Using this system a student can register itself into different course's and view grades reports submitted by Professor for a particular course. Professor can select a course to teach for current semester and submit grades. Whereas a Registrar maintains student as well as professor information and close registration through which information is provided to billing system. The services provided by the Course registration system are provided in the table given below along with their operations. This software application is developed on the concept of service oriented architecture frame work by using ASP.Net, XML and Microsoft SQL Server as the programming language tool

4.3 Case Study 3: Online Banking System

Online Banking System Provides a variety of services to its Customers. These services include Account Opening Service, Transaction Services, online Funds transfer, online account status checking service, online Loan Application submission and displaying Foreign Currency rates. This software application is developed on the concept of service oriented architecture frame work by using ASP.Net, XML and Microsoft SQL Server as the programming language tool. Services provided by the system are listed in the table given below.

5. Results and discussion

Project No	Description	Estimated Efforts through Function Points	Estimated Efforts through Proposed Function Points	Actual Efforts	MRE1 (Proposed)	MRE2 (FP)
P1	Online Resume Bank	201	222	256	0.13	0.21
P2	Course Registration System	204	218	240	0.09	0.15
P3	Online Banking System	237	254	283	0.10	0.16
MMRE					**0.11**	**0.18**

Root Mean Square Error for Proposed and Actual Estimates

Project No	Description	Estimated Efforts through Function Points	Estimated Efforts through Proposed Function Points	Actual Efforts
P1	Online Resume Bank	201	222	256
P2	Course Registration System	204	218	240
P3	Online Banking System	254	283	152
Root mean Square Error (RMSE) Proposed				**16.60**
Root mean Square Error (RMSE) Function Points				**26.54**

DISCUSSION

Magnitude of relative error describes that proposed estimates are closer to actual efforts as compared to function points estimates. For Project P1 the MRE (Jaswinder 2008) is 13 % as compared to 21%, which describes that MRE for proposed has lesser error value than Function point estimates. For Project P2 MRE is 9 % as compared to 15%, and finally for Project P3 MRE is 0.10 % as compared to Function point MRE 0.16 %. Mean Magnitude of relative error for proposed effort estimation is 0.11 where as for function point estimation it is 0.18, which presents 7% difference among the effort estimation techniques.

6. Conclusion.

Service oriented Architecture (SOA) is a promising new area of software engineering, where services are combined together to form a design structure, which not only fulfills the requirements of users but also support the business processes to compete with its competitors. On the other hand Function Point

estimation technique is recognized as an accurate estimation technique amongst its competitors, the calibration of its Value Adjustment Factor, and consideration of Integration efforts shows improvement in its estimation accuracy, and inclusion of new factors in its GSC's, proves that now it properly address SOA characteristics. Results shows the when effort estimation is performed through proposed work flow model the MMRE was 11 %, and 18 % from function point estimation, which shows the proposed work flow model produce lesser error as compared to function point estimation with a difference of 7%. Root mean square error (RMSE) also presents a notable difference in the estimation efforts. Correlation analysis also shows that correlation coefficient (r) has more accurate value as compared to its counterpart. Moreover the Integration efforts were some time ignored, due to its diverse behavior and loose coupling nature, by considering and addressing this important factor will capable the developers to provide accurate estimate for SOA applications to plan schedule, resources and men power for software development.

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