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Research Article

Using Wage Rate Analysis to Determine Software Project Scale

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Abstract: Software development projects are usually categorized as large, medium or small scale but these terms have not been described in a quantifiable manner. Although there are some specific measures, e.g., function points, however, scholars agree that they cannot be generalized for all software projects. Project managers realize that the resource allocation for small, medium and large scale projects is intrinsically different in nature and at the same time managers struggle to identify the scale of the project. Therefore it is pertinent to be able to identify the scale of the project before resource allocation. This study presents a study which is based on quantifiable measurements of project success factors and shows a way to identify the project scales. Data from the study is used to determine and quantify project scales in terms of cost, time and team size. Wage rate analysis is used to demonstrate the validity of our results. After quantifying the project scales the underlying wage rate is compared with wage rate reported in contemporary studies to successfully validate the results of our study.

Keywords: IT professional wages, project scaling, Software professional wages, software project scales, software wage rate analysis

INTRODUCTION

Software development is an activity that requires some cost and time to develop a software project. The resource intensiveness depends on the scale of the project. Projects with extensive scope require the allocation of more software resources while the small projects can be completed with less resources (Shahzad and Safvi, 2010; Mathkour *et al*., 2011; Shahzad and Said, 2012). The use of the terms like Large Scale, Medium Scale and Small project is very common however the exact quantifiable meanings of the word don't exist in concrete terms.

Patanakul (2014) has identified how the large scale projects can be effectively managed but has not identified what the large scale project is and how it can be defined. Wallace and Sheetz (2014) have focused on the project measurements by considering their characteristics but did not advise about the scaling of the projects. Molokken and Jorgensen (2003) has performed a review study that investigates the as yet identified findings of the existing cost estimation models to identify how the small and large scale projects can be differentiated. The effort to differentiate continues without having quantifiable grounds. Shahzad and Said (2012) has worked on the identification of scales but the study has its inclination towards risk identification rather than the software scales, therefore, the parameters of quantification are not very clearly described. The software projects are scaled as Large, Medium and Small projects. Although the scale of the projects is commonly known yet the scaling mechanism is not. The questions like "What is a large project?", "What is a small project?" yields the results that are not quantifiable and are relative to specific time, place and individual's argument. Sometimes the researchers address this scaling problem by considering the Lines-of-Code or Function Points (Sharif and Basri, 2011a) while others believe that these measure are too specific to be generalised for any software project (Leung and Fan, 2002).

The literature although provides scattered pieces of information on project scaling yet no detailed study has been conducted in this regard to suggest the specific scales (Johnson, 2006; Sharif and Basri, 2011b). As the resource allocation for small, medium and large scale software projects varies in nature it is important to identify the scale of the project before the resource allocation can be done. In order to accomplish the project scaling a quantitative study is deemed necessary to allow the categorization of the projects based on the small, medium and large scale based on the quantifiable measurements of the project success factors (Shahzad *et al*., year). Based on the identified gaps in the project scaling, following research questions are raised:

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Table 1: Means of sending survey and responsiveness

No.	Means of sending survey	Count
1	Paper survey	11
2	E-mail	130
3	Facebook groups	50
5	Skype text request	10
6	Google talk link forwarding	39
7	Phone call requests	20
8	Text message requests	40
Total		300

Table 2: Statistics for the survey conduct

Measure	Number
Confidence level	95%
Confidence interval	4.96
Population	*
Population accessed	300
Sample size	170

*: The actual population size is unknown (System, 2012)

Q1: What are the project scales and how they are identified?

Q2: How the identified project scales are validated?

Q1 is addressed by conducting a quantitative study that identifies and quantifies the project scales while Q2 demonstrates how the identified project scales are validated.

The objective of this study is to identify the project scale by virtue of the quantitative study and identify the numeric and consolidated ranges of values that can define the project scales in absolute terms. The findings of the quantitative study are compared with the findings of the wage rate analysis to see that if they confirm each other. Their triangulation to a alike values demonstrates the validity of the study.

METHODOLOGY

Survey on project scaling: Keeping in view the nature of the research the questionnaire is sent to software developers, managers and graduate students and researchers indifferent institutes in order to gather a consolidated response. As we identify that accessible population size is 300 and we determine the confidence interval to be 4.96, 170 responses are needed. Following means were used to make this survey reach 300 respondents (Table 1).

The Survey reached to 250 Individuals directly, while three groups of software risk management and project management were also included in the survey having average size of 20. It can therefore, be argued that the survey link and information was sent to 300 respondents to be able to respond. Following statistics are used for this survey (Table 2).

Confidence level demonstrates the level of confidence that we have on the response to be correct and precise. Usually a confidence level of 95% is used in the research although 99% is occasionally used. The confidence interval determines the amount of acceptable results and is presented with the ± symbol. The population size in this very case can't be established with precision as the respondents are scattered and knowing the estimated population may itself require a detailed study. It is recommended that if the population size is unknown it may be ignored as increasing the population size to extensively large scale only increases the calculations (Origin, 2012). It is therefore assumed that a population size of 300 is reasonable to be considered for conducting the survey. The survey is conducted using survey monkey (Mathkour *et al*., 2011) system and results are discussed in the proceeding section.

SURVEY RESULTS

Eight project factors are being considered for this research (Shahzad and Said, 2012), namely Cost, Time, Number of team members, Computational resources, Quality focus, Requirement Change, Software risk management and Availability of Re-usable code. The factors Cost, Time, Number of team members, Computational resources can be categorised as participatory factors due to the fact that the estimation can't be completed without them. The factors are quantitative in nature and their quantification can be done by surveying them. While the factors Quality focus, Requirement Change, Software risk management and Availability of Re-usable code are observatory factors and they observe that the process is mature and free from the known errors. These are qualitative factors.

The survey performed to collect the responses about the cost, time and team size about the medium and large projects was sent to individuals possessing high academic and technical profile, it was identified that the sample size should be 170 with the accessible population of 300 and confidence interval of 4.96. The survey was left open for 2 weeks and responses were collected accordingly. The summary of the results is presented in Table 3 and the table entries are average values extracted from the responses. In Table 3 and the rest of this study the unit for costs and wages United States Dollar $.

C.M. consultants Assasa (2007) have estimated that if the software and hardware purchase is not massive, more than 90% of the total budget is spent on the software development and the activity to develop the software. Keeping in consideration that 90% budget is allocated for the team members we reach to Table 4 that demonstrates the 90% allocation of the total budget. Ahead of the 10% allocations for the computational resources, some resources have to be allocated for maintaining the quality of the software and ensuring that the cost does not run out in that process.

If the requirement changes are done late in the project the cost of the project massively increases and so do the other project factors mentioned in this study. The quality focus (standardization, documentation and maturity level) may be given an additional 5% resource allocation. The Software Risk Management and re-usable Code development are also given resource allocation.

Table 3: Development cost for medium and large scale projects

	Medium		Large		
Project factor	Min.	Max.	Min.	Max.	Response count
Development cost	91,200	988,000	1,047,280	3,800,000	170
Time (weeks)	24	52	53	100	170
Team size	5	25	26	50	170
Computational resources % of cost	10%	10%	10%	10%	
Quality cost	35%	35%	35%	35%	

Min.: Minimum; Max.: Maximum

Table 4: Development cost, time, team size for medium and large project

	Medium		Large	
Project factor	Min.	Max.	Min.	Max.
Average cost	132,240	1,432,600	1,518,556	5,510,000
Average time (weeks)	24	52	53	100
Average team size	5	25	26	50

Min.: Minimum; Max.: Maximum

As the requirement changes have huge impact their focused allocation has 20% allocations. So the four observatory factors have the allocation of 35% of the development cost. And this 35% can't be separated from the project development cost as the software delivered must possess quality and should be secure. In Table 4 the total cost of a project including the cost and quality revision cost have been added. The total cost of a project is shown in Table 4.

From Table 3, it is observed that the development cost to develop medium scale software is 92,400 which require the effort of 5 individuals for 24 weeks. If we break down the weeks into days and then hours it becomes:

Per person per hour wage rates = (Avg. Cost/ (no. of weeks *5 *8)) /average team size

Wage rate analysis: The average wage rate per hour in our study for all software projects is $19.20. A survey conducted in 7 different countries measuring the approximate wage rate determined that the average wage rate is 19.03, with UK being the most expensive country and having the highest average wage rates per hour approaching to 35.5 $ while Philippines being the least expensive for software development and having the average of 7.65 $/h wage rate.

By virtue of this survey and the literature study presented in above section, it can be concluded that the results of both studies confirm and validate each other.

The medium scale project is assumed to have spread on at least 24 weeks, anything smaller than that can better be considered assignment instead of a complete project. The respondents have argued that a medium scale project should at least contain 5 people and should take around 24 weeks to complete. As a result of the survey the respondents believe that such projects' development cost should not be less than $91,200.

Table 5: Average wage rates for IT professionals

Project scale	Complexity	Development cost	Per person per hour wage
Medium	Minimum	91,200	19
	Maximum	988,000	19
Large	Minimum	1,047,280	19
	Maximum	3,800,000	19
Average			19

The respondents have mentioned that a medium project should not exceed by 25 people and should take around 52 weeks to complete at maximum. As a result of the survey the respondents believe that such project's development cost should not exceed by 988,000 $. While the respondents have identified that a large project may contain up to 50 people and should take around 100 weeks to complete. As a result of the survey the respondents believe that such projects development cost should not exceed by 3,800,000 $.

While doing the estimation, it is important to note that by taking the average of the wage rates normally followed in six countries the average is 19$. It is important to consider that if more countries are added the average may be slightly different. It is common that for the large scale project high focus is to be established on quality, documentation, risk management and the need of computational resources is to be evaluated adequately.

Result validation: The results of the survey presented in Table 4 are validated by the results of contemporary study shown in Table 5 and 6. Table 5, in response to the responses gained from the survey concludes that by decomposing the cost and time required to develop any project the per hour cost is 19$ for medium and large scale projects. Table 6 is result of the analysis of the wage rate across several countries in the world and it concludes that the average wage rate is 19.03. It can be observed that Table 5 and 6 converge to like findings and hence they validate each other.

Table 6: Country-wise average wage rates for IT professionals

Min. cost/h in USD	Max.	Avg.	Country	Source
5	15	10.00	India	Software (2012)
14	23	18.50	Malaysia	Malaysia (2012)
2.93	12.39	7.65	Philippines	Payscale (2012)
10	12	11.00	Pakistan	Alibaba (2012)
32	39	35.50	UK	Market (2012)
28	35	31.50	USA	Labs (2012)
Average		19.03		

Min.: Minimum; Max.: Maximum; Avg.: Average

CONCLUSION

This study is focused to identify the project scales by conducting a quantitative study. The quantitative study resulted in the evolution of the development cost of the medium and large scale software projects. The wage rate analysis performed in this study is unique in the sense that evidence is non-existent from literature that establishes this type of analysis to determine the project scales. The study concludes that a medium scale project's total development cost must be between the $91,200 and $988,000, while the time to develop should be between 24 to 52 weeks and team size should be between 5 and 25. For large scale project's total development cost must be between the $ 1,047,280 and $3,800,000, while the time to develop should be between 53 to 100 weeks and team size should be between 26 and 50. The study concludes that the average wage rate for software and IT professionals is 19 $/h. The quantitative findings of this research have been validated by contemporary studies.

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