

Empirical Review of Impact of Requirement Engineering Processes on Software Delivery Time

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ABSTRACT

In Today's Competitive world, Customer Satisfaction is of utmost importance for an organization to survive. Customer satisfaction merely depends on – On time delivery and quality of Software and both these factors are directly dependent on Requirement Engineering—One of the most important, but difficult phase of software development. Requirement Engineering can be simply defined as identifying a problem's context, locating the customer's requirements within that context and delivering a specification that meets customer needs within that context. Theories say that RE practices has direct impact on the success of any software project. The objective of this paper is to explore the impact of requirement analysis on Delivery of software. For this paper, I have conducted survey on some of Indian Companies and try to Put light on the gap between software practices found in theory and in real practice in Indian Scenario which would provide us with the opportunity to assess the effects of Requirement Engineering over Software Delivery Time.

Keywords – Requirement Engineering, Requirement gathering, Requirement Implementation, RE Processes, Software Engineering

1. INTRODUCTION

The very first question which is considered by most of companies or entrepreneurs starting on a new Software Project, is "**What are the chances of the success of this project?**". Success of software project is measured in terms of Delivery Time, Quality, and Cost. Studies conducted by major research groups' show that 60% of Software Projects fail today. After the project has been taken up by the company, one of the first functions of the Analysis team is the process of **Requirement Definition**. This is the phase where customer requirements are collected. Requirement Definition comprised of – Requirement Elicitation, Analysis, Definition and Management and is one of the most important and often most neglected activities of the Software development life cycle. A good requirement model fosters communication between the business and IT by enabling them to share a common vision of the system's solution prior to implementation. This will ensure that the system meets the business needs, can be

delivered on time, and have the level of quality and flexibility to easily accommodate future business needs. If the requirements are not collected and defined properly at the first phase of software development, it leads to rework which in turn leads to delayed projects, over budget projects or unreliable projects

In Today's Competitive world, Customer Satisfaction is of utmost importance for an organization to survive. Customer satisfaction merely depends on – On time delivery and quality of Software and both these factors are directly dependent on Requirement Engineering—One of the most important, but difficult phase of software development.

1.2 Requirements engineering (RE) : RE can be simply defined as identifying a context of problem, gathering & understanding the client's requirements within that context and delivering a specification that meets client's needs within that context. There are many requirements methodologies that claim to do this, for example, soft systems methodology [1], scenario analysis

[2], and UML [3]. Some companies use one methodology, some use other. But if we can make out that if that the application of 'x' method will produce the higher success rate in most of the cases and 'y' method can produce right requirements irrespective of the problem's characteristics, then it will be helpful to software development companies to develop successful projects.

Apart from methodologies, there are other factors also which are responsible for project's success such as size and type of project, Type of team, Client's or user Involvement, Understanding of problem to client, No. of users etc. One method may lead to success in one company but not for other.

This is conventional wisdom and unsurprisingly, the creators and vendors of requirements methodologies claim, with one exception [4] that their approach is a hammer and all problems are nails. While there are many factors other than just application of a requirements methodology that influence the success or failure of software projects in practice, in this paper, I focus only on requirements engineering.

1.3 Processes of Requirement Engineering :

Requirement Engineering Process is divided in to two main categories [5]:

a. **Requirement Gathering** : Requirement gathering is divided in four phases :

1. Requirement Eliciting
2. Analyzing Requirements
3. Specifications of Requirements
4. Validating requirements

b. **Requirement Implementation:**

Requirement implementation is actual execution of the requirements in the software development phases.

1.3.1 Elicitation of requirements can be done using five different techniques [6]

i) **Traditional techniques:**

Traditional methods comprise of technique of gathering data using questionnaires, surveys, interviews, task analysis, domain analysis and Introspection.

ii) **Cognitive techniques:** In this technique requirement engineer collect and

prioritize requirements. Some of the cognitive techniques are Repertory grids, card sorting, laddering and protocol analysis.

iii) **Group elicitation techniques** : This technique involves eliciting requirement through the involvement of team or groups of software engineers. Group works, brainstorming, JAD requirement workshops and protocol analysis relate to group elicitation techniques.

iv) **Prototyping** is the technique which is used for elicitation purpose when requirements are not clear or when urgent stakeholders' feedback is required to proceed further.

v) **Contextual techniques** involve ethnography, conversation analysis and observations/social analysis that serve as an alternative to the traditional cognitive techniques.

1.3.2 Requirement Implementation / Development:

The input/output of RE process, devised by Kotonia and Sommerville, intake the following five inputs:

- a) Existing system information
- b) Stakeholder needs
- c) Organizational standards
- d) Regulations
- e) Domain information

It also generates three outputs, namely agreed requirements, system specification and systems models. This process is general and flexible as for all the organizations only the requirements can differ, but these inputs and outputs always remain fixed [5,6].

Linear Requirements Engineering Process Model, envisaged by Linda Macaulay, is a simple model, primarily used for administering small projects. This model is composed of five tasks in sequences :

1. Conceptualization
2. Problem analysis,
3. Feasibility study,
4. Analysis and Modeling,
5. Requirement documentation [5].

Linear Iterative Requirements Engineering Process Model, conceived by Kotonya and Sommerville, emphasizes on accurate specifications for the system and validation of RE multiple times from the stakeholders. The model is iterative that lasts until the final requirements are attained and stakeholders get satisfied.

Iterative RE Process Model, formulated by Loucopoulos and Karakostas, is performs requirement engineering in several iterations and is suitable for those software development projects which are released version after version. The model consists of three simple phases: elicitation, specification and validations.

Spiral Model of RE Process, suggested by Kotonya and Sommerville, performs RE process in spirals (or coil), where each spiral twists represent complete version of the requirements on the basis of which the system is expected to be developed. Each spiral is further divided into four quadrants namely, specification elicitation, requirements analysis and negotiation, requirements documentations and requirements validations. The model is capable to handle risks can increase project cost and compromise quality, such as specification delay, requirements change, low ROI etc.

2. Objective of Study :

Theories says that RE practices has direct impact on the success of any software project. The objective of this study is to explore the impact of requirement analysis on Delivery of software. In this technological era , huge amounts of funds are directed towards information technology (IT) software development. Despite the enormous advances in the IT industry, there are still many failed IT team projects. Knowing the common underlying problems that cause most IT team projects to fail will help teams avoid making those same mistakes over and over. Researching the causes of several team projects that failed will provide insight for future IT team project development. It is inevitable that history will repeat itself if the history is unknown. This may cause disastrous and costly consequences.

3 Research Methodology

The aim of this paper is to understand how RE Processes helps deliver the project on time and investigating the relation between delivery time and RE process. If such relations were thoroughly and consistently established, they could be used for enabling better scheduling of delivery of project.

For this paper, I have conducted survey on some of Indian Companies and try to Put light on the gap between software practices found in theory and in real practice in Indian Scenario which would provide us with the opportunity to assess the effects of Requirement Engineering over an entire project life cycle

To prepare the evidence to check the Requirement engineering tools used in Indian Companies and to see the effect of RE on Delivery of Software, a detailed Questionnaire is prepared and is filled by the authorized employees of the companies such as Infosys, Cognizant Technology (Pune), Market RX(Gurgaon), One World Technology(Ambala), Ameotech Informatics(Chandigarh), GENPACT, GTech Informatics, Automatic Data Processing India Pvt. Ltd, Silex Softwares Pvt. Ltd.(Ambala). The questionnaire was divided in four parts :

- (1) Details and profile of the company
- (2) Profile of the person filling the questionnaire
- (3) Details of Project
- (4)Details of RE techniques and processes used.

Many closed-ended questions were used to minimize the length of the questionnaire, however participants were offered an "Other-please specify" option to prevent forced answers from occurring.

After collecting the data from these companies , analysis of the data is done using cross tables and graphs in SPSS Statistical Tools.

In order to understand the nature of RE Processes, a qualitative as well as quantitative approach is employed. The sample size used in this study involved **38** software development projects from **nine** companies of Pune, Gurgaon, Chandigarh and Ambala. Due to this reduced sample size, the use of qualitative research methods was preferred. Furthermore, the main aim of this study is to formulate a hypothesis

about the relationship between RE process success and the delivery time.

4.Questionnaire Results & Analysis:

I received completed questionnaires from number of respondents, reporting on 38 distinct projects. As noted earlier, the majority of our respondents were developers or project managers from pune, Gurgaon,Chandigarh and Ambala based companies. The responses to set of 22 questionnaires described 38 projects, 21 regarded as successful as delivered on time and 12 unsuccessful as not delivered on time. The Survey questionnaire had mixed type of questions . Questions no Q4-Q15 are closed :Categorical, Q17-Q35 are Yes –No type Questions , Q36-Q38 are scaled one .

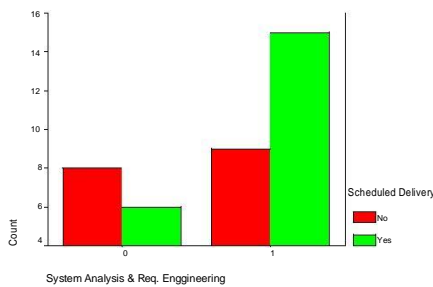
Questions & Responses:

Q Select the Development Team Structure :

- System Analysis ,Requirement Engineering
 - Testing
 - Technical Writing
 - No specialists , all are developers
1. System Analysis , requirement engineering as Development Team Structure

Development Team Structure As System Analysis , Requirement Engg. * Scheduled Delivery Crosstabulation

		Q32		Total
		No	Yes	
System Analysis, Requirement Engineering	0	Count 8	6	14
		% within SYSREQE 57.1%	42.9%	100.0%
1	Count 9	15	24	
	% within SYSREQE 37.5%	62.5%	100.0%	
Total	Count 17	21	38	
	% within SYSREQE 44.7%	55.3%	100.0%	

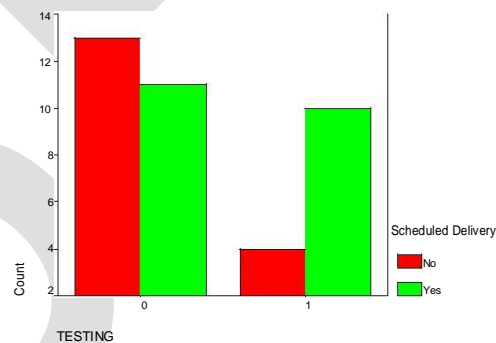


Analysis:

24 Projects which had development team structure as System Analysis and Requirement Engineering , 15 projects were delivered on time which leads to 62.5% success rate.

2.Testing as Development Team structure

		Scheduled Delivery		Total
		No	Yes	
TESTING 0	Count	13	11	24
	% within TESTING 54.2%		45.8%	100.0%
1	Count	4	10	14
	% within TESTING 28.6%		71.4%	100.0%
Total	Count	17	21	38
	% within TESTING 44.7%		55.3%	100.0%

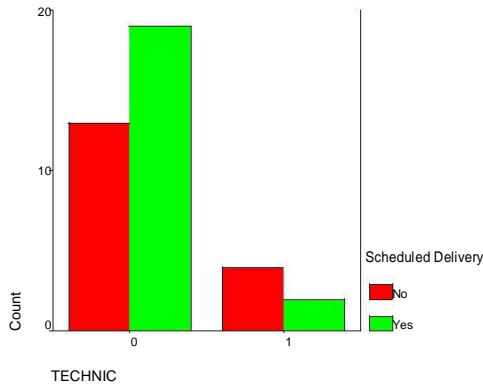


Analysis:

14 Projects which had development team structure as System Analysis and Requirement Engineering , 10 projects were delivered on time which leads to 71.5% success rate

3.Technical Writing as Development Team Structure :

		Scheduled Delivery		Total
		No	Yes	
TECHNICAL 0	Count	13	19	32
	1	4	2	6
Total		17	21	38

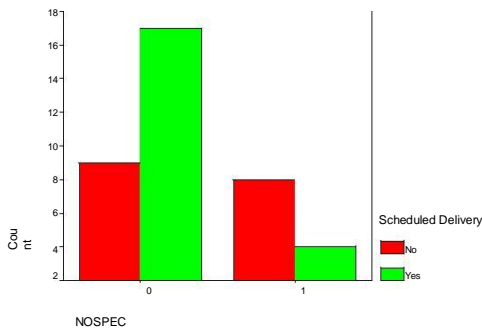


Analysis:

6 Projects which had development team structure as Technical Writing, 2 projects were delivered on time which leads to 33.3% success rate.

4. No Specialists all are developers as Development Team Structure:

	Scheduled Delivery		Total
	No	Yes	
NOSPEC 0	9	17	26
1	8	4	12
Total	17	21	38



Analysis:

12 Projects which had development team structure as Technical Writing , 4 projects were delivered on time which leads to 33.3% success rate.

Top two Development Team Structure with high success rate are:

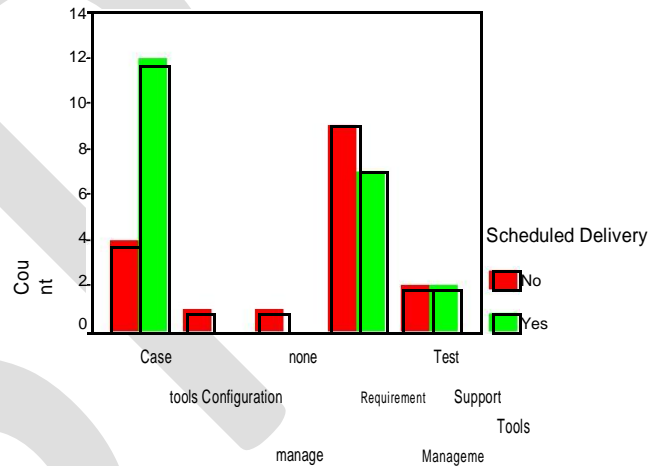
1. Testing 71.4%
2. System Analysis 62.5%

Requirement Engineering

Q Development Tools used :

- Test support tools
- Case tools
- Configuration management tools
- Requirement management tools

	Scheduled Delivery		Total
	No	Yes	
Q5(Development Tools Used) Case tools	4	12	16
Configuration management tool	1	0	1
none	1	0	1
Requirement Management tool	9	7	16
Test Support Tools	2	2	4
Total	17	21	38



Analysis

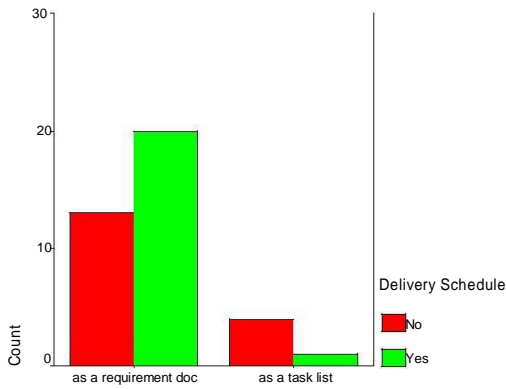
16 Projects which had development tool used as case tools , 12 projects were delivered on time which leads to 75% success rate.

16 Projects which had development tool used as Requirement Management tool , 7 projects were delivered on time which leads to 43.75% success rate.

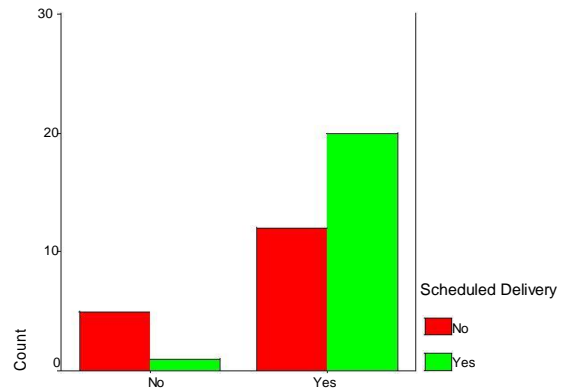
Q. Requirement document created

- a) as a requirement document
- b) as a task list

	Q32		Total
	No	Yes	
Q6 as a requirement document	13	20	33
as a task list	4	1	5
Total	17	21	38



Q6



Requirement management Policies

Analysis:

Out of 33 projects which created requirement document 20 were delivered on time. Success rate is 60%.

Analysis:

If the management policies are defined success rate is 62.5%, more number of projects are delivered on time.

Q. General Guidelines

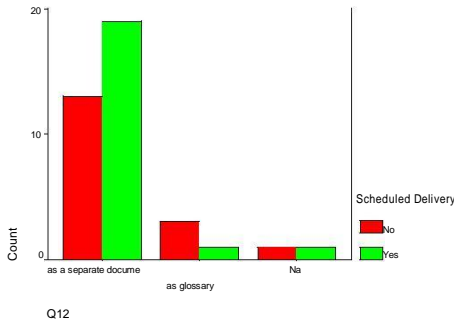
- Requirements management policies defined Yes NO
- Document validation checklists defined Yes No
- Requirement analysis checklists defined Yes No
- Process defined Yes No
- Problems analysed Yes No

Q. Data Dictionary created

- as a glossary
- as a separate document

		Scheduled Delivery		Total
		No	Yes	
Requirement Management Policies Defined	No	5	1	6
	Count			
	% within Q10_S1	83.3%	16.7%	100.0%
	Yes	12	20	32
	Count			
	% within Q10_S1	37.5%	62.5%	100.0%
Total	Count	17	21	38
	% within Q10_S1	44.7%	55.3%	100.0%

		Scheduled Delivery		Total	
		No	Yes		
Q12	as a separate document	Count	13	19	32
		% within Q12	40.6%	59.4%	100.0%
	as glossary	Count	3	1	4
		% within Q12	75.0%	25.0%	100.0%
	Na	Count	1	1	2
		% within Q12	50.0%	50.0%	100.0%
Total		Count	17	21	38
		% within Q12	44.7%	55.3%	100.0%



Analysis:

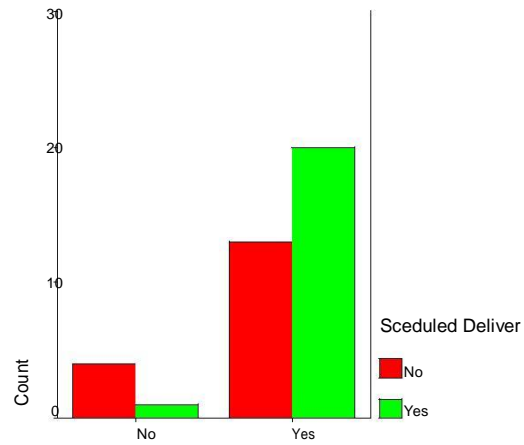
Out of 32 projects which created data dictionary as separate document ,19 were delivered on time. Success rate is 60%.

Q Templates for requirements exists.

		Scheduled Delivery		Total
		No	Yes	
Templates for Requirement Exists	No	Count 4	Count 0	4
		% within Q13 100.0%	% within Q13 .0%	
Yes	Count 13	Count 21	Count 34	34
		% within Q13 38.2%	% within Q13 61.8%	
Total	Count 17	Count 21	Count 38	38
	% within Q13 44.7%	% within Q13 55.3%	% within Q13 100.0%	

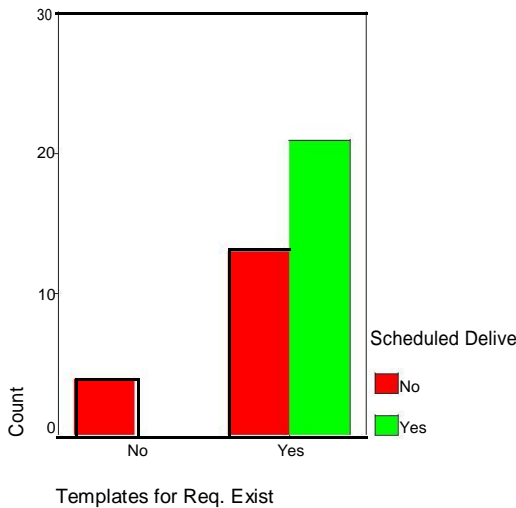
Q Were the stakeholders committed and involved while eliciting requirements?

			Q32		Total
			No	Yes	
Q17	No	Count 4	Count 1	Count 5	5
		% within Q17 80.0%	% within Q17 20.0%	% within Q17 100.0%	
Yes	Count 13	Count 20	Count 33	33	
		% within Q17 39.4%	% within Q17 60.6%		% within Q17 100.0%
Total	Count 17	Count 21	Count 38	38	
	% within Q17 44.7%	% within Q17 55.3%	% within Q17 100.0%		



Analysis:

If the stakeholders are committed ,success rate is 60%

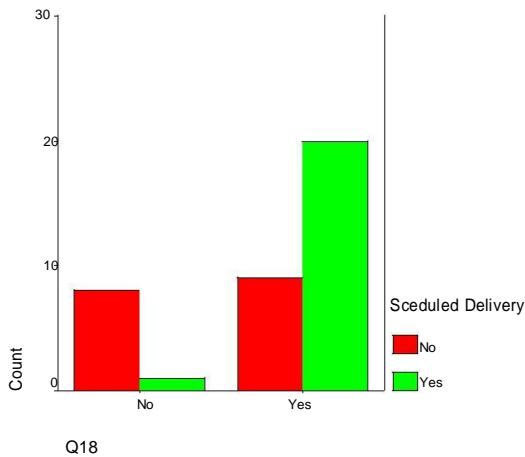


Analysis:

If templates for requirement exists , success rate to deliver project on time is 61.8%.

Q Was there high level of customer/user involvement.

		Scheduled Delivery		Total
		No	Yes	
Q18	No	Count 8	Count 1	Count 9
		% within Q18 88.9%	% within Q18 11.1%	% within Q18 100.0%
Yes	Count 9	Count 20	Count 29	29
		% within Q18 31.0%	% within Q18 69.0%	
Total	Count 17	Count 21	Count 38	38
	% within Q18 44.7%	% within Q18 55.3%	% within Q18 100.0%	



Analysis:

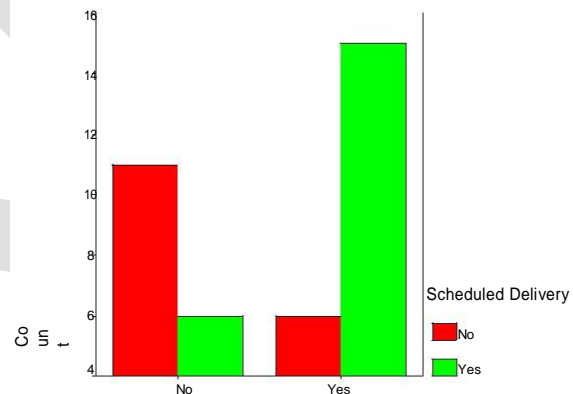
If the Number of customers/users are less, success rate is higher.

Q Were requirements complete and accurate at project start?

			Sceduled Delivery		Total
			No	Yes	
Q22	No	Count	11	6	17
		% within Q22	64.7%	35.3%	100.0%
	Yes	Count	6	15	21
		% within Q22	28.6%	71.4%	100.0%
Total		Count	17	21	38
		% within Q22	44.7%	55.3%	100.0%

Q Was a there high level of customer/user confidence in the development team

			Sceduled Delivery		Total
			No	Yes	
Q19	No	Count	6	0	6
		% within Q19	100.0%	0.0%	100.0%
	Yes	Count	11	21	32
		% within Q19	34.4%	65.6%	100.0%
Total		Count	17	21	38
		% within Q19	44.7%	55.3%	100.0%



Analysis:

If there is high level of customer/user confidence in the development team, 65.6% projects were delivered on time.

Q Were You affected by large numbers of customers/users

			Q32		Total
			No	Yes	
Q21	No	Count	12	17	29
		% within Q21	41.4%	58.6%	100.0%
	Yes	Count	5	4	9
		% within Q21	55.6%	44.4%	100.0%
Total		Count	17	21	38
		% within Q21	44.7%	55.3%	100.0%

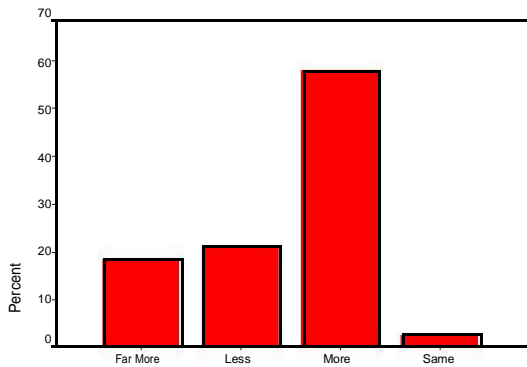
Analysis:

If requirements are complete and accurate at project start ,success rate is 71.4%.

Q How the RE process affected Scheduling of the project.

Far More More
Same Less
Far Less

	Freq uenc y	Perc ent	Valid Percent	Cumul ative Percen t
Valid Far More	7	18.4	18.4	18.4
Less	8	21.1	21.1	39.5
More	22	57.9	57.9	97.4
Same	1	2.6	2.6	100.0
Total	38	100. 0	100.0	



Q36

Analysis:

18.4% Interviewers believe that RE processes far more affect Scheduling of the project and 57.9% believes that it affects more.

Conclusion:

From the above discussion it is clear that projects which used one or the other analysis technique had higher success rate compared to those which did not use any RE Above responses and graphs shows there is positive relationship between RE processes and delivery time. Good and effective RE process helps in better scheduling of delivery time leading to projects delivered on time.

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