

Software Process Models and their Implementation in Software Companies

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Abstract—In this paper a comparative study has been done on the selection and usage of Software Process Models in the Software Companies being adopted for project/product development. Most of the targeted companies selected for analysis are working on small to medium level projects. The triggering factors that influence the selection of a Process Model have been identified and discussed. Descriptive statistical tools have been used for the analysis of datasets collected through the questionnaire. The results taken out of the collected datasets show the Linear or Phased models (Waterfall, V Model, Incremental, etc) to be the mostly used models in the software companies, who are working on small to medium level projects. The triggering factors that were identified as the key factors towards the selection of a process model are, a model's cost effectiveness, time efficiency, feasibility, risk reduction and streamline activity flow.

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Index Terms—Process models in industry, most frequently used process models.

I. INTRODUCTION

In software companies pivotal products are software. Every software company has a team of engineers to develop software's for them following a specific software development strategy. The software development strategy that includes process, methods and tools layers along with three generic phases i.e. definition phase, development phase and support phase is so called *software process model* or a *software engineering paradigm*[1].

The aim of this paper is to identify the factors that play a vital role for the selection of a process model being selected for a project or a product, their importance and contribution ratio.

Various process models are available for the development of a software product. Some major processes models have been discussed below:

The Waterfall model, one of the basic models in which software development follow step wise approach. "It comprises of Requirement Definition, System and Software Design, Implementation and Unit Testing, Integration and System Testing and finally Operation and Maintenance phase."[2]. **V model** is a variation of waterfall model, which starts with left side of V i.e. requirement modeling, architectural design, component design and code generation, afterwards it moves up to the right side of V where series of tests are conducted to validate every model created on left side of V. In this model verification and validation goes hand by hand [3]. **Incremental model** combines elements of linear sequential model (applied

repetitively) with the iterative philosophy of prototyping. This model delivers software in small and usable pieces called "increments"[1]. In **spiral model** each process is represented by spiral. Each loop in spiral represents a phase of a software process. Each loop in spiral is split into four sections, i.e Objective Setting, Risk Assessment and Reduction, Development and Validation, Planning [2]. **Rational Unified Process Model** is an object oriented software process model. It has five phases i.e. Planning, Modeling, Construction, Deployment, Communication [3]. **Extreme Programming** is used for agile software development. Five core values for extreme programming are Communication, Simplicity, Feedback, Courage, and Request. Stages of extreme programming are Planning, Design, Coding and Testing [3]. **Scrum** is also for agile software development. Its basic activities are Requirement, Analysis, Design, Evolution and Delivery. Scrum incorporates a set of process patterns that emphasize project priorities, compartmentalized work units, communication, and frequent customer feedback [3]. Rapid Application Development is an incremental software development process model. If requirements are well understood and project scope is limited then RAD is used to develop fully functional system in very short time period [1].

The paper has been organized in 6 sections. Section 1 is already discussed. Related work is described in section 2, the methodology being adopted for survey is sectioned to section 3, analysis of process

model selection has been placed in section 4, and section 5 presents results and discussion. Section 6 sketches the future work and conclusion.

II. RELATED WORK

“The *process* of developing and maintaining a product or a service plays a crucial role in determining the quality level of the product or service but also the cost of developing, supporting and maintaining it” [5]. There has been great interest increased in development of guidelines and framework for cost and time efficient process model for successful product development. Francisco et.al. “Analysed the existing approaches towards SPI (Software process improvement) which focus on SMEs (Small and medium software enterprises) and which report a case study carried out in industry. A further objective is that of discussing the significant issues related to this area of knowledge, and to provide an up-to-date state of the art, from which innovative research activities can be thought of and planned”[4]. Sergio et.al. Discuss “the mechanisms a process language should possess in order to support changes. They illustrate the solution adopted in the context of the SPADE (software process analysis, design, and enactment) environment and discuss how the proposed mechanisms can be used to model different policies for changing a software process model” [5]. Sergio et.al. Discussed “the problems that a software development organization must address in order to assess and improve its software processes” [6]. Nabil et.al. “The main objective of their research is to represent different models of software development and make a comparison between them to show the features and defects of each model” [7]. “A Survey of System Development Process Models explore the similarities and differences among these various models and will also discuss how different approaches are chosen and combined to address practical situations” [8].

III. METHODOLOGY

The survey has been conducted in a systematic way that is based on the proposed guidelines by Kitchenham [9]. The steps in this systematic survey research are:

- Research questions
- Research process
- Inclusion and exclusion criteria
- Quality assessment
- Data collection

A. Research Questions

The first and most important step is to pose clear and well defined research question. A basic question taken from the questionnaire is:

Q1. Which process model is most frequently used in software companies being working on small to medium level projects?

In order to dig out the factors that motivate the software engineers to select a specific process model, list of questions are being prepared. Table 2 shows the list of those questions:

TABLE: 2 SUB RESEARCH QUESTIONS

#	Question
1	Whether the selected process model is cost effective?
2	Whether the selected process model is time efficient?
3	What is the effect of year of experience on area of specialization?
4	Selected approach is feasible in use and field due to which factor?
5	Is flow of activity according to process model?
6	Whether selected process model helped to reduce risk or not?
7	What is the frequency of developed product documentation?
8	What is the frequency of satisfaction from the selected process model?

B. Search process

The search process adopted in this survey is a manual process. The help has been taken from different books, research papers, journals, government documents and software companies that are working on small to medium level projects. The books and research papers relevant to the topic were studied individually by each researcher and collected the important data. Survey questions were distributed among the companies working in different technologies and business areas.

C. Inclusion and Exclusion criteria

In this systematic research survey the included criteria is listed below:

- Software companies that are working on small to medium level projects.
- Questionnaires were filled by the candidates who were regular employees in the companies.
- The employees had at least three years of software development and management experience who filled the questionnaires.

The exclusion criteria for this systematic research survey include:

- Only those companies are considered for analyses that are working on small to medium level projects.

- The questionnaires that were filled by the people who were not employed in a software companies have not been considered for analysis.

D. Quality Assessment

The survey was evaluated using the criteria based on the following Quality assessment questions:

#	Criteria	Answer
1	Whether the data was collected from target population?	Yes
2	Whether the collected data was appropriate for analysis?	Yes
3	Whether the collected data was able to answer posed research question?	Yes
4	Whether the inclusion and exclusion criteria were followed accordingly?	Yes

E. Data collection

“Questionnaires are sets of questions administered in a written format. These are the most common field technique because they can be administered quickly and easily. Questionnaires are time and cost effective [10]. Therefore, a questionnaire was a worth selection to collect the information about the targeted domain. The questionnaires were distributed among the 55 Software companies who were working in different technologies on projects from small to medium level. About 45 positive responses were collected and they have been sketched in the coming sections. The list of software companies who responded are given in appendix A at the end.

IV. ANALYSIS

A. Sampling Frame

The target population for the survey was software companies that are working on small to medium level projects. The questionnaires were sent to about 55 software companies and positive response was received from 45 companies.

B. Data collection

A questionnaire is an easy mean of collecting the objective information, for the same reason they have been used for data collection.

C. Statistical Method

In order to analyze the collected data the statistical data analysis tool SPSSv16 has been used. Some other statistical techniques are also used i.e. Cross tabulation and Frequency.

“**Cross tabulation** (or **crosstabs** for short) is a statistical process that summarizes categorical data to create a contingency table. They are heavily used in survey research, business intelligence, engineering and scientific research. They provide a basic picture of the interrelation between two variables and can help find interactions between them.”[11]

“In statistics the **frequency** (or **absolute frequency**) of an event T is the number T_i of times the event occurred in an experiment or study. These frequencies are often graphically represented in histograms”[12]

D. Objective of study

Objective of this systematic research survey is to find out which process model is frequently used by the software companies working on small to medium level projects. During the analysis processes it was tried to find out the important triggering factors for the selection of a specific process model. For example, a process model was selected for a project because it is:

- Cost efficient
- Time efficient
- Economically feasible
- Satisfy requirements
- Reduces risks

During the research, it was intended to find out the fact that after the selection of a specific process model whether or not the companies follow the formal conventions. For example, proper activities flow, product documentation.

V. RESULT & DISCUSSION

The focus of this section is on the results and discussions derived from the analysis of datasets. Several statistical techniques have been used to map the data on charts. For Example, Frequencies and Crosstabs (chi square) from Descriptive Statistics in SPSSv16.

TABLE 3: TIME EFFICIENT PROCESS

Process model * Process Model Time and cost Efficient Cross tabulation

Count					
		Process Model Time and cost Efficient			
		<i>Yes</i>	<i>No</i>	<i>Others</i>	Total
Process model	Linear or Phased Approaches	24	4	2	30
	Iterative Approaches	7	3	0	10
	Agile Approaches	6	0	0	6
	No defined approach	1	4	4	9
Total		38	11	6	55

TABLE 4: FEASIBLE PROCESS MODEL

Feasibility of Process Model * Process model Cross tabulation

Count						
		Process model				
		<i>Linear or Phased Approaches</i>	<i>Iterative Approaches</i>	<i>Agile Approaches</i>	<i>No defined approach</i>	Total
Feasibility of Process Model	Yes	26	10	6	2	44
	No	1	0	0	5	6
	Others	3	0	0	2	5
Total		30	10	6	9	55

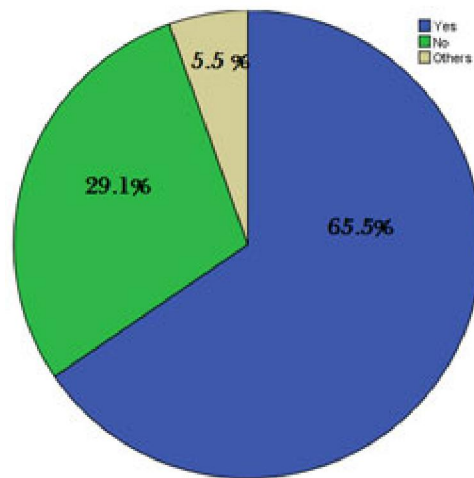


FIGURE 1: PROCESS MODEL FREQUENCY

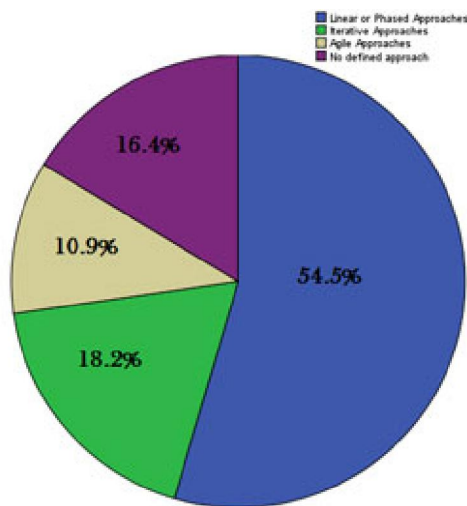


FIGURE 2: DOCUMENTATION OF DEVELOPED PRODUCT

Figure 1 shows that 54.5% software companies are using Linear or Phased Approaches. For example, Waterfall, V model, Incremental, etc. 18.2% companies are using Iterative process approaches that include Spiral, Microsoft Solutions Framework, Rational Unified Process. 10.9% companies are using Agile approaches that include Extreme Programming, Scrum, Rapid Application Development etc. Response from some of the companies showed that they are not using any specific process model as an approach.

Figure 2 shows that most software companies are maintaining product documents for reference and future maintenance e.g. 65.5%.

Table 3, which includes Cross tabulation (chi Square) for Process Model and Time Efficiency shows that Linear or Phased approach is most time efficient in nature as per this analysis report for small to medium level projects.

Table 4, which demonstrates Cross tabulation between process model and project feasibility concludes the fact that software companies finds the processes model very helpful. The analysis concluded the tendency of satisfaction by adoption of a Software Process Model for a product in Software Company. For example, 61.8% answered the adoption of a processes model as satisfactory while 38.2% as Unsatisfactory. It was determined through this analysis that appropriate process model helps to reduce risks in product development. Risk reduction was mostly found as a key factor in Linear and Phased Approach as per this analysis is concerned. It was also reported that in most of the software companies the activities flow according to their respective process model. Consequently, it would be better to say that the product's activity flow is smoother in Linear or Phased approach. It is also a worth indication that the people who answered the questions were at different experience level and were using different technologies, however, most of them suggested the Linear or Phased Approach.

I. CONCLUSION & FUTURE WORK

This study was conducted to get knowledge about the usage and selection of a process model that is adopted during the product development in the software companies. For this analysis, most of the companies that were selected are working on small to medium level projects in different technologies. Only few companies were included who are working on large business projects. Survey Research are normally conducted to collect and analysis data, and conclusions are made by the end of analysis. In this analysis, Questionnaires were distributed to collect the objective information from the companies. Statistical tools have

been used to map the analysis into figurative form using SPSSv16 (descriptive statistics i.e frequency distribution, chi square). The factors that played an imperative role behind the selection of a specific process model are also discussed.

Future work may embrace analyzing the Software Development Approach being adopted by the companies working on large scale business projects. It may also be a key concern for research projects where the requirements and methodologies keep changing until the deployment of a product.

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Appendix A

TABLE: 1 LIST OF COMPANIES NAMES

Companies Names	
Serial No	Company Name
1	Deans Techno
2	Gravity
3	iFahaja
4	JsoftSolution
5	Oxygen Interactive
6	Nextbridge Pvt. Ltd
7	A to Z E-Payments
8	CommTEL
9	Dynamix
10	Expert Systems
11	Exact Technologies
12	Famz Solutions
13	FEnD Consultants
14	GOF IT
15	iFAST
16	ION Resource Group
17	IT Artificers
18	IT Intellisence
19	Litle bit Solution
20	Micro Innvoations and Tehnalogy
21	Micro Logic
22	M.TechnoBits
23	Multi biz
24	National Developers(NSD)
25	Personal Hub
26	Precise Technologies
27	Savvy Solutions
28	Smart Bhaktar Solutions
29	Shalazon
30	Soft Cahsers
31	SoftLea
32	StepNext
33	System Technologies
34	System Developers
35	Tehno Wing
36	Telic Technologies Pvt.Ltd
37	Velocity Techno
38	Viper Technologies
39	Vision International
40	Xerox Technologies
41	WebSol
42	Xpret Technalogy
43	zSoft
44	Netsol Technologies
45	Tech Wizards

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