

## A STUDY OF SOFTWARE ENGINEERING PRACTICES PERFORMED IN SRI LANKAN SOFTWARE COMPANIES

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**ABSTRACT:** *A collection of concepts, principles, methods and tools which are used in software engineering (SE) industry is known as the SE practices and they are important to work with the software development life cycle (SDLC). Delivering high quality products within budget limits and on time is a comprehensive problem and a very big challenge in the information technology sector and also software engineers make failures while they try to develop software. Drawbacks in existing software practices and not choosing appropriate practices may cause above problems. The aim of this study is to analyse the characteristics of SE practices exercised by the Sri Lankan software development industry, to identify the interrelationship between those practices and describe the challenges of those SE practices. Initially, a mapping study was performed on five electronic databases to find the past related studies and the research gap. Then an empirical study was conducted as a survey study for 148 numbers of software engineers in randomly selected software companies in Sri Lanka and collected data was analyzed using statistical software. According to the results, the most popular target sector are information technology and telecommunication and most popular software types are web application and mobile application. Agile software development methodology is new and widely used in Sri Lankan software industries. Requirement documentation is the main requirement engineering practice. Testing all features independently by a testing team is used in testing related practices. Manual testing is used more than automation testing. Insufficient documentation is challenge to the software maintenance phases. Most organizations are using project planning, tracking, and risk management tool and significant correlation was found between sub factors of factor requirement, design, development, testing separately. The results of the study conclude that strength and weakness of SE practices in Sri Lankan context.*

**Keywords:** Questionnaire, Software development life cycle, Software development practices

### 1. INTRODUCTION

A maturation has happened in the field of SE in the present world. SE is meant for developing, managing, modifying, monitoring and supporting software to get an output of a reliable and effective software products or services (Garousi, Coşkunçay, Betin-Can, & Demirörs, 2015). It defines methodologies of enhancing software products. Market and customer needs are changing rapidly and it is essential for businesses to supply software products within time schedules, budgets and quality limits (Garousi et al., 2015). SE came up with these needs to meticulously manipulate the tasks of developing software. In order to systematically plan the projects SDLC model helps a lot as a vital role (Fujita & Pisanelli, 2007).

SE consists of few processes like requirement engineering, designing, implementation, testing, controlling, and quality assurance and it widely focuses on developing the software. Based on the team size, software

engineers must select appropriate procedures and methodologies to develop certain software. Also, they must be concerned about risks, weaknesses and about application domains (Garousi et al., 2015). There are specific practices used in SE when developing software methodically and systematically and software developing organizations select best practices and tools to work in their projects. Every software-based organization tries to work with best SE practices to achieve goals perfectly (da Costa & Sabbatini, 2001)

Software industry in Sri Lanka follows various types of SE practices at present. If those practices become obsolete or inappropriate for some dilemmas, there will be a crisis in the industry and a huge resource wastage. There is a common problem for software companies to choose good practices and tools to enhance their project accuracy and efficiency. This research intends and will be helpful to find out the strengths and weaknesses of the SE field in Sri Lanka and to identify the most used SE practices and identify the interrelationship between those practises and these findings will help both starting up and growing software companies.

The objective of this research is to analyse characteristics of SE practices exercised by the Sri Lankan industry in order to obtain analytics about SE tools, techniques, methodologies, principles, models etc. used by experts in the field. And identify interrelationship between those areas. That will help researchers and SE community who dwell around the world to choose best and latest trends used in the industry. Providing that information is one of the tasks of this research. That will assist them to work on fruitful projects and to fulfil society requirements. Extracting opportunities and strengths that this field can have and identifying challenges, weaknesses and threats are also some of the goals of this survey.

## **2. RESEARCH METHOD**

There should be a research based on quantitative approach in order to examine the characteristics and a high-level view on SE practices that is being used in Sri Lanka software industry. Then only it will help to identify the latest trends, challenges and benefits in SE practices. In order to achieve it, the information should be collected from different groups of employees who are working in software related companies in Sri Lanka. This information should be collected from all the different types of responsibilities in the field.

In order to collect a large amount of data from a large population with a cost-effective manner the quantitative survey method was chosen (Rizkallah, 2015) and an online questionnaire was used with a proper scale and a scope in order to collect information. Questionnaire was designed under two main research

model one of model for correlation analysis (Figure 1) and other model for descriptive analysis and demographics analysis (Figure 2). Some of the questions in the questionnaire had quantitative per-designed multiple-choice answer, some questions were quantitative per-designed per single choice answer, some questions were polar questions that can select only true and false and some of the questions were provided with several options. The responses were captured by using Five-Point Likert-type scale that allows the respondents to make their level of agreement such as never (1), seldom (2), sometimes (3), frequently (4) and always (5). Respectively scores of 1,2,3,4, and 5 were assigned for the above-mentioned categories. All responses can be divided in to three main categories; (i) values over 3, (ii) values below 3 and (iii) values equal to exactly 3 (Shahzad, Xiu, & Shahbaz, 2017).

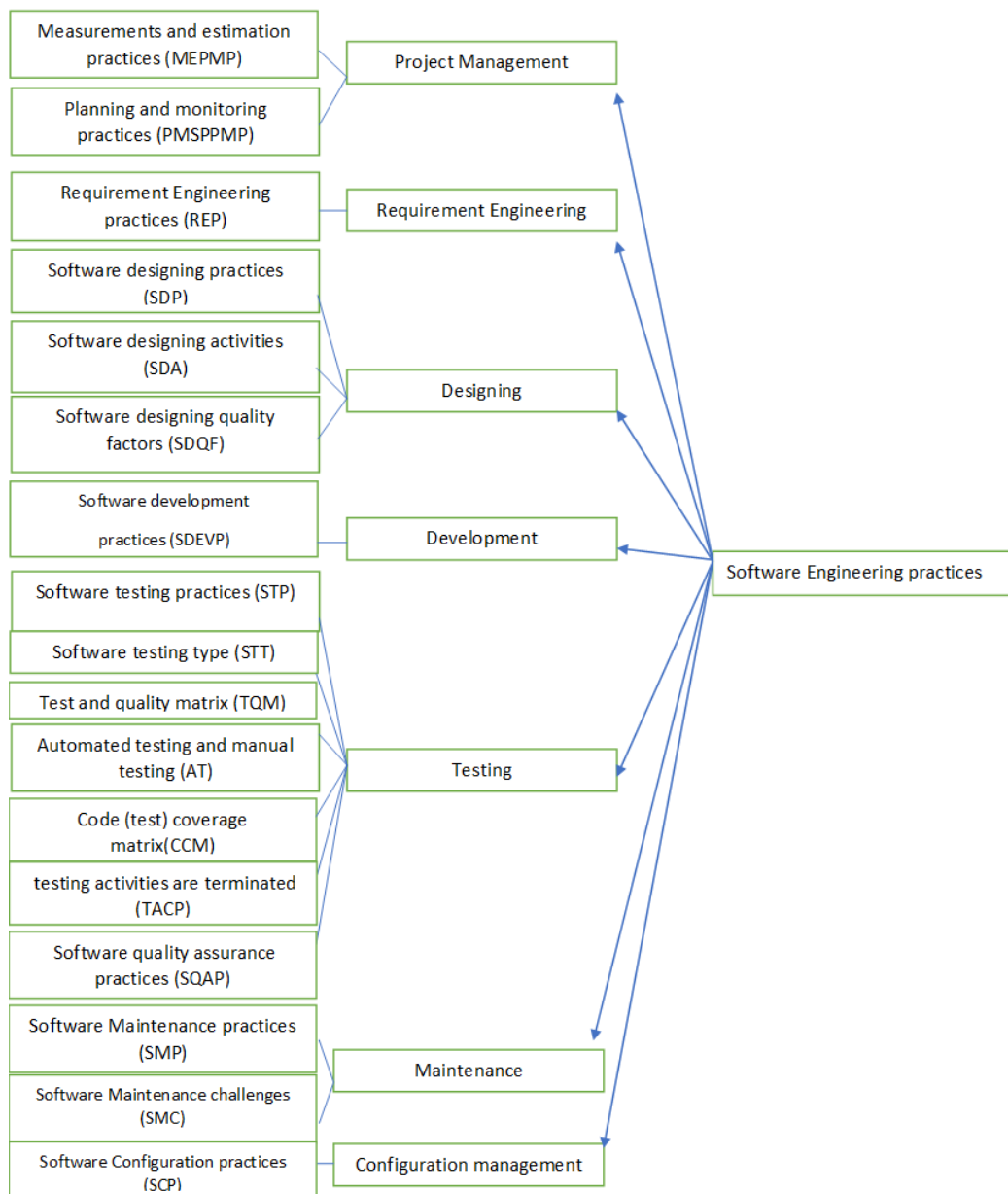


Figure 1. Correlation Analysis research model

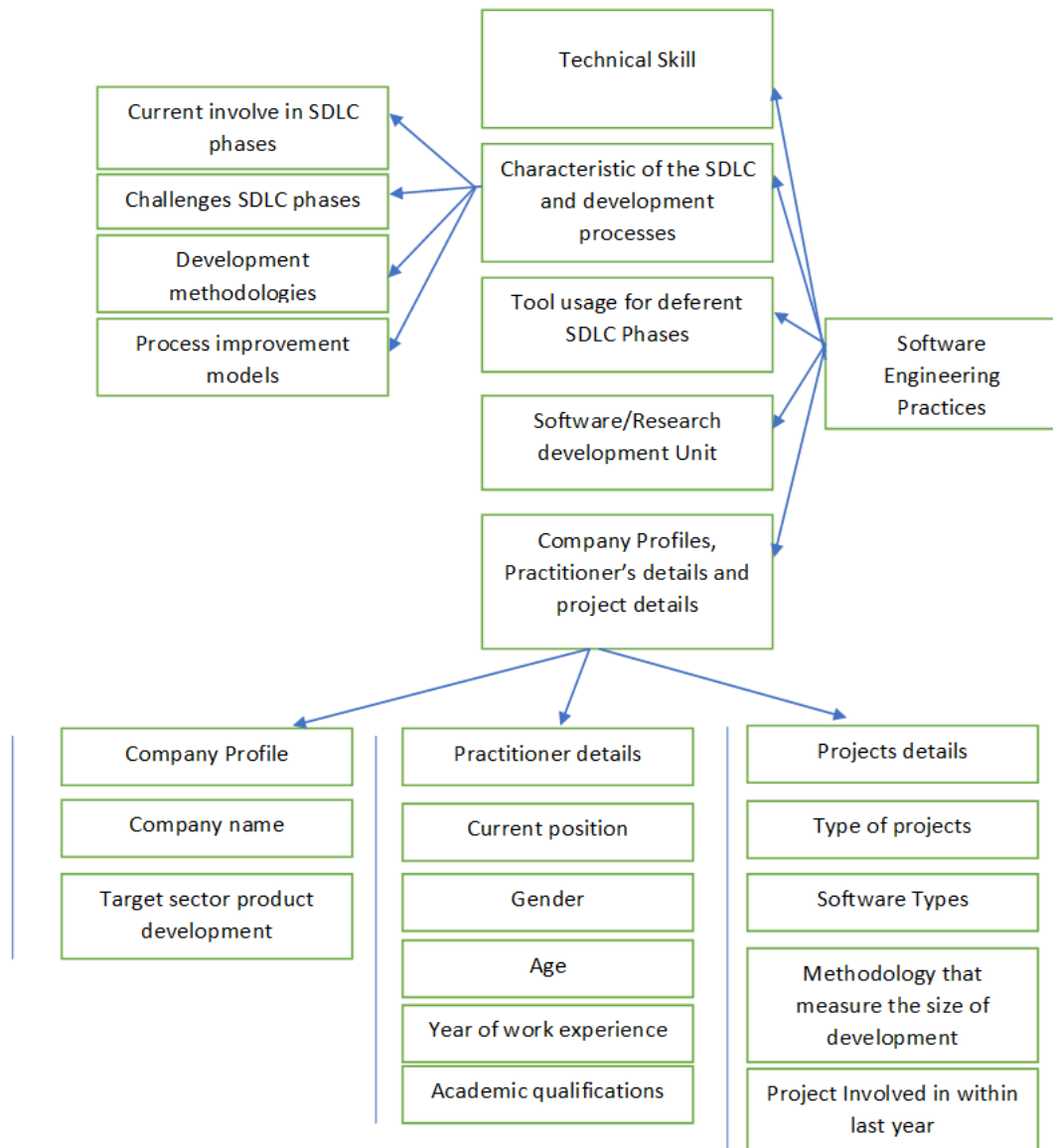


Figure 2. Demography analysis and Descripts analysis research model

SE practitioners gave a huge support in order to understand and evaluate above set of questions and their consultations were much helpful when reviewing the research questionnaire. After the confirmation of the above questionnaire, pilot test was done by software engineers in Sri Lankan software companies. They were invited to complete the survey, to comment whether the questions were legible, understandable and any other comments on the questionnaire survey. Used SPSS software for checking the reliability of the questionnaire. After finalizing all these above, questionnaire was redeveloped using google forms and link was sent to the employees in companies to answer them easily through internet. Responses were analyzed using the SPSS statistical analysis software.

Information were gathered from different groups of employees who are engaging in activities related to software development in companies.

Information were collected from the management and different positions of software development related persons.42 questions were distributed in electronically within a period of one month. 148 persons were participated in the research.

### 3. RESULTS AND DISCSSIONS

In this survey, out of 148 participants 107 (72.3%) were male, 41 were female (27.7%). Most of the participants of the sample were between 22-35 years old (66.2%). Six (4.1%) participants were above 35 years old and others were below 25 years. The sample covered different groups of employees who were engaging in activities related to software development in companies. In this survey most of the participants were software engineers (55.4%). When consider academic level, most of the participants were bachelor's degree holders (83.1%). Most of the participants produce project base projects (54.7%) and most focused software types were web applications (86.5%). Most of the companies carry out only 2 projects or less in the last year (62.8%). There were a very good mix of companies and project profiles, hence were useful to the survey.

Most of the respondents were mostly involved in implementation, maintenance, design and requirement phases and most of the challenges they had faced, were related to implementation, testing, requirement and design SDLC phases. Agile is the widely and newly used SE methodology (67.6%). By reviewing the data, we found that it would be interesting to conduct cross-aspect analyses using Pearson correlation matrix as shown in table 1. The correlation of "We formally analyse requirements" (AR) and "We validate software requirements" (VR) was found as the highest correlation ( $r = 0.943$ ,  $p < 0.01$ ).

Table 1. Requirements Engineering Practices cross-aspect analysis result

	AR	VR	PRO	IOT	RAD	RIH	PRA	EIT	IRT	FAD
AR	1	<b>0.943**</b>	0.397	0.754**	0.628**	0.545*	0.868**	0.431	0.855**	0.933**
VR		1	0.451	0.722**	0.629**	0.497*	0.824**	0.361	0.836**	0.851**
PRO			1	0.442	0.526*	0.330	0.494*	0.344	0.468	0.365
IOT				1	0.539*	0.725**	0.844**	0.476	0.775**	0.717**
RAD					1	0.215	0.616**	0.658**	0.615**	0.597*
RIH						1	0.771**	0.483*	0.600*	0.510*
PRA							1	0.610**	0.939**	0.868**
EIT								1	0.621**	0.539*
IRT									1	0.886**
FAD										1

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

Most of people used creative design practice as their design practice because features or enhancements may not be properly completed in earlier phases in SDLC. Prototyping, Design Patterns and Product Design are the three most frequently performed design type activities and algorithm design is the least popular design type

activity. Maintainability and usability were found to be the important design related quality attributes. From the data it was found that all the variables have got positive correlations. The correlation of software design practices (SDP) and software design quality factor (SDQF) was found as the highest correlation ( $r = 0.928$ ,  $\rho < 0.01$ )

Mostly used software development practices were responsible to develop higher level design and implementation for project. In Sri Lanka, mostly used programming languages are JavaScript based languages (37.8%) (Table 2). From the data it was found that all the variables have got positive correlation. The correlation of “Build when a feature or features are completed” (BF) and “Design and coding are carried out together” (DC) was found as the highest correlation ( $r = 0.610$ ,  $\rho < 0.01$ ).

Table 2. Programing languages

Programing languages	Count	%
Java	54	36.5%
C#	39	26.4%
PHP	34	23.0%
Python	13	8.8%
C++	6	4.1%
Go	2	1.4%
Java Script Base languages	<u>56</u>	37.8%
Swift	7	4.7%
Ruby on Rails	9	6.1%
Arduino	1	0.7%
ABAP	3	2.0%
Beralina	1	0.7%
MATLAB	1	0.7%
React JS	0	0.0%
Pega	1	0.7%
angular	1	0.7%
Groovy	1	0.7%
R	1	0.7%

Mostly used testing related practice is testing all new features independently by a testing team. In Sri Lanka mostly used test types are user acceptance testing, functional system testing, integration testing. In Sri Lanka manual testing is used more than automation testing. Mostly used test coverage metrics is decision coverage metrics. Most of the organizations follow Test-last development (TLD). Most widely used criterion for ending testing activity is fixed budget test activity. Most widely performed quality practices are well-defined verification and validation targets (e.g., defect density). From the data it was found that all the variables have got positive correlation. The correlation of “software testing practices” (STP) and” software testing type” (STT) was found as the highest correlation ( $r = 0.858$ ,  $\rho < 0.01$ )

Corrective maintenance and Adaptive maintenance are the most widely-used maintenance types whereas perfective maintenance is the least used. Insufficient documentation and lack of tools in support of maintenance is also an important type of challenge in software maintenance phases.

Most popular software configuration management release planning practices are separate test and release environment, representatives from development are involved in release decisions, and representatives from QA or test are involved in release decisions. The most popular product support practice is developers work with clients on-site in which a dedicated person is assigned to each major client.

Most popular measurements and estimations in project management practices are perform systematic cost and effort estimations before each project. The most widely performed planning and monitoring projects management practices is perform (weekly/monthly) progress meetings.

According to the results, 54.1% of the companies have research and development units (RDU) available in the company and 45.9% of them don't have a research and development unit. Most people agreed (51.4%) that their company has technical skill gap among different people and most people strongly agreed (43.9%) that new technologies are used in software development. Most organizations use project planning, tracking, risk management tools, version management, release build related tools, and documenting requirements tools.

Some important results were derived from the survey. These results will be much significant for future in SE field. If industry use poor SE practices, definitely it will affect badly for the project not only technically but also economically and psychologically. If good SE practices are used, it will be a good investment for organizations' culture, resources and considerations (Garousi et al., 2015).

The results of this research could be very important for start-up companies. When those companies have to decide in the first-time which kind of practices should be used in different kind of software development phases such as requirement engineering, design, implementation, testing, project management, maintenance, configuration management, they may want to know what the most efficient and current mostly used practices of industry is and inter relationships among each other. The results of this research provide mostly used practices that are currently being used in software development industry in Sri Lanka and inter relationships among each other. Therefore, these results could be used in their decision making.

Another importance of this research is that even for already established organizations also can use these results for their decision-making process regarding how their existing software development practices could be improved according to industry mostly used practices. In order to achieve sustainable growth and competitive advantage over rivals, they need to continuously improve and update their existing practices. Research findings provide updated information for that.

There are some limitations in this research. One of them is the number of participants of the research. It will be more reliable if this is bigger. Another limitation is that the

number of companies participated in the survey is small and if the number of companies is high, results will be more accurate. Some companies didn't participate for this survey due to privacy reasons like they didn't like to reveal their SEpractices due to their company policy. This survey used an online survey to collect quantitative data. If it could be collected qualitative data from face to face interviews, results would be more reliable and accurate. This questionnaire was divided in to some categories for participants' responsibilities like project manager, business analyst, quality engineers etc. But the participants who had worked in all these responsibility areas were very low in count.

#### **4. CONCLSIONS**

This paper discusses about the results and implication of a survey on SEpractices in Sri Lanka conducted in 2018. As the initial step mapping study was done to find the past literature related to the research topic. From that study, seventeen papers were identified as primary studies and mapping study was performed on five electronic databases to find the research gap. The intention of this study was to gain an understanding and an insight into to the extent to which SEpractices have been adopted by the organizations in Sri Lanka, the benefits the organizations have gained and realized, the problems they have faced when adopting and implementing these practices and finding SEpractices for start-ups and growing organizations and find the inter relationship each one by one SDLC phases. We believe that the findings reported in this study will expand in time with the development of the software industry in Sri Lanka.

The observations gained through this survey concluded us that there is a long way to improve on using well established software development, requirement Engineering and testing, design related practices. We also have observed most used SEpractices used by the practitioner's in Software industry of Sri Lanka.

- i. In this study we identify most used SEpractices and inter relationship about deferent SEpractices in Sri Lanka. Some of them are
- ii. The most target sector was IT and telecommunication
- iii. The most seen software types were web applications and mobile applications
- iv. Widely and newly used SEmethodology is Agile
- v. Requirement documentation is the top requirement engineering practice and analysis requirement and validate requirement are secondary top practices in requirement engineering.
- vi. The correlation of "We formally analyze requirements" (AR) and "we validate software requirements" (VR) was found as the highest correlation.
- vii. Most people use creative design practice as their design practice.
- viii. Prototyping, Design Patterns and Product Design are the three most frequently performed design type activity and algorithm design are the



- least popular design type activity and Maintainability and usability were found to be the important design related quality attributes.
- ix. The correlation of software design practices” (SDP) and “software design quality factor” (SDQF) was found as the highest correlation
  - x. Mostly used Software development practices are responsible to develop higher level design and implementation for project develop, design and coding are done together in project.
  - xi. In Sri Lanka mostly used programming languages are JavaScript based languages.
  - xii. The correlation of “Build when a feature or features are completed” (BF) and “Design and coding are carried out together” (DC) was found as the highest correlation
  - xiii. Mostly used testing related practices is testing all new features independently by a testing team.
  - xiv. In Sri Lanka most use test type is user acceptance testing.
  - xv. In Sri Lanka manual testing is used more than automation testing.
  - xvi. The correlation of “software testing practices” (STP) and “software testing type” (STT) was found as the highest correlation
  - xvii. Most popular Software configuration management release planning practices are separate test and release environment.
  - xviii. Most popular measurements and estimations in project management practices is perform systematic cost and effort estimations before each project.
  - xix. The most widely performed planning and monitoring projects management practices is perform (weekly/monthly) progress meetings.
  - xx. Most of the people agreed for company have technical skill gap among different people.

In this study we focused on identifying all technical aspects in SEpractices. Social Engineering practices were ignored in this study although they are important among the practitioner’s and in fact practitioners tend to have problems in social aspects.

We have planned to investigate some future work directions and they are Perform a good analysis for the future, Similar studies are needed to be carried out in different regions and countries to identify and compare latest trends in SEpractices, Further studies need to be carried out on technical aspects and a study need to be done on social aspects on SEpractices.

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