

Software Engineering Research: A Review of its paradigms

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Abstract

This article reviews and analyzes different types of paradigms applied in software engineering research. Several paradigms including case study, empirical method, replication and experimentation have been applied in past research. However due to maturity level of research paradigm on software engineering, mature knowledge are needed to help researchers shape their research. This paper provides reviews of available paradigms related to a software engineering research.

Keywords. paradigm; software engineering research;

1. Introduction

Paradigm is a model of process that defines the activities that occurs from start to end [14]. Software engineering paradigm categorized in two areas: scientific and engineering paradigm. The scientific paradigm are measures, analyze and validate hypothesis of model while engineering paradigm are observing the existing solutions and suggests better solutions [14]. In software engineering research inductive paradigm is applied to further relate with software process, product, people and environment where its approach is known as engineering or empirical method applied [14]. Besides, analytic paradigm is commonly applied for mathematical method in developing theory or empirical observations where the projects developed claim to be research development and it is best applied in discussing research activities. Nevertheless, paradigms can be applied in many areas of observations, case study, qualitative and quantitative methods; replication, empirical method and experimentation [14] are discussed further in this paper. The following section describes several paradigm of software engineering research.

2. Literature Review

For less than four decades, software engineering paradigm was known as cascade paradigm, structured paradigm, object oriented paradigm or others [2,6] where the first publication and conference was held in late 1960s [6]. Generally software engineering research has two faces that are scientific and engineering. Engineering face is known for the engineering principles applied successfully to build complex computer system [2]. However scientific face applies the engineering principle and contributes knowledge to the research study. Paradigms used in software engineering research are typically descriptive or formative paradigms [6]. Empirical sciences or constructive paradigms known as scientific research that derives positive paradigms consists of cultural or social problems. Types of positive paradigm are typically used in organization to evaluate process implemented using a tool. Mixed paradigms are popular with the existence of behavioral science research paradigm [6] while engineering paradigm illustrates the limitation or weak spot identified in descriptive paradigm, for example, development of new model, techniques etc. Figure 1 below, illustrated further on the two types of paradigms that used by software engineering researchers and software engineers.

	Engineering Paradigms (e.g. Object-Oriented)	Scientific Paradigms (e.g. Positivism)
Engineering Use (goal: to produce software)	EE Like a Design Metaphor	ES To understand the specific domain and developing assumptions
Scientific Use (goal: to produce knowledge)	SE Like a specific solution approach	SS To produce software engineering knowledge

Diagram 2.1: Perspectives of paradigms in software engineering research [2]

Diagram 2.1 above describes on cross product of four perspectives, which are EE (Engineering paradigms) and ES (Engineering paradigms used by software engineering researches while SE (Scientific paradigms) and SS (scientific paradigm used by software engineering researchers) [2]. Although there are many research methodologies that researchers could follow, these methods applied scope towards the scientific or engineering paradigm.

3. Review Process

Selecting a review topic can be useful with applying initial strategy to determine number of literatures available and the data that makes the review infeasible. Next the researcher would refine the subject area to summarize and gather data. Example of review process is focusing on areas that cause significance to the selected topic by consulting with specialist or reading with intention to identify the area of interest and also to indicate the availability of data for the selected topic. The information gathered then structured to suit the related information using a systematic approach. This has benefit the researcher in obtaining comprehensive and relevance information related to the question or information searched where the results obtained are more focused. Digital search have provide opportunity for researchers to find literatures using computers or electronic databases. Literature databases that provide access to rich quantities of information able to quickly retrieve through manual search. The types of databases exist deals with specific information for relevant topic of research. The researcher has identified few databases like Springer, ACM, and IEEE transaction on software engineering that contains rich journals on empirical methods, computing and case study journals related to software engineering field. Identifying the keywords is useful method in finding literature. Alternative keywords with similar meaning are useful for further information gathering. Another strategy is with the use of combination command called 'Boolean operators' which are 'And', 'Or' and 'Not' where existing literature and systematic reviews are important sources of data which offers good overview research undertaken. After overview of article is completed, systematic and critical review of the content is important to summarize the information highlighted by the researcher that concern with the title of the article, author, purpose, methodology, findings or discussion and conclusion as discussed in diagram 3.1, below. Finally, the final stage of appraisal is writing short summary of article that includes key thought, comments, strengths of the article read.

Literature Review Process	
1.	Selecting the review topic
2.	Searching literature
3.	Gathering, reading and analysing the literature
4.	Writing the literature
5.	References

Diagram 3.1: Steps in Literature Review

4. Results

The paradigms in software engineering have been further scaled into many forms of case study, observations, replications etc. From these forms the software engineering research relies on either scientific or engineering paradigm based on investigating contemporary phenomena. Decision in choosing a rela-

tive paradigm depends on the research question of a particular paper [10,15], for example case study method. The approach of case study research process objectives is to increase knowledge about individual, groups or organizations. Besides replications in experimental research is considered as scientific knowledge [1]. Reasons for usage of replication in software engineering research is to identify if results from previous experiments are reproducible. Thus replication does contribute to scientific paradigm objectives in knowledge acquisition for a certain research. [1]. Experiments are popular in software engineering research where it uses the inductive approach that specifies on empirical method use for conducting experiments [14] which helps to establish the scientific and engineering basis of software engineering research. Next is the data collection methods, the mixture of qualitative and quantitative methods have justified strengthening results in findings [11]. Besides, experiment or replication methods are also used for data collection methods in software engineering research [15]. Furthermore, each software engineering paradigm consist advantages that suitable according to the topic of research undertaken. Observational research study suitable for case study paradigm however experimental and replication paradigm are suitable for research that applies experiments in laboratory for research findings. While quantitative and qualitative research paradigm are suitable for acquiring and gathering information from questionnaire and interview type structured questions constructed for research results findings.

5 Conclusion

This paper provides reviews of paradigms that exist in software engineering research which are case study, qualitative and quantitative study, experimental and empirical paradigm shifts that researchers apply in research. Each paradigm suggests guidelines and steps to produce successful research from applying such paradigms while each type of paradigm have scientific and engineering approach in software engineering research based from the chosen paradigm approach for a particular research.

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