Software Engineering Fresh Graduates Career Choices and Software Industry Demands: An Empirical Analysis

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Abstract

Software Engineering is one of the modern engineering disciplines. The efficiency, novelty, creativity, and excellence of the products and services of the software industry significantly depend on the education being provided in universities. Bearing in mind the petition for experienced software engineers in the market and the software industry's emergent demands and trends, empirical analysis has been done by collecting the data from fresh software engineering graduates, professionals in the field of software engineering and online job portals. The main focus behind this study is basically to guide final year software engineering students to start a career in the specific areas (requirements engineering, software analysis, design, implementation, testing, and maintenance) of software engineering, identified by mapping the interest of fresh graduates, professional software engineers, and software industry demand. Our results show that professionals' feedback is similar to the jobs available on portals, which means our professionals provided more realistic feedback. Also, results show that more people are interested in requirement engineering but jobs are very limited in requirement engineering, software design, and testing. As far as software analysis, software implementation and software maintenance are concerned, professionals suggest that more people should select these areas as there are more job opportunities here. To summaries, there is a positive relationship between professionals' feedback and industry job openings. Both suggest software implementation is the richest job area. The state-of-the-art syllabus can be planned for software engineering program by keeping in mind the trends and demands of the software industry.

Keywords: *Career Choices, Software Development, Software Engineering, Software Industry*

1. Introduction

Some researchers in the field of computer science started to utilize the term "Software Engineering" during 1960s without providing a reasonable definition [1,2]. They communicated the expectation that software developers would figure out how to develop their applications with control and demonstrable skills. Prof. Brian Randell defined the term software engineering as "multi-person development of multi-version programs" [3]. The educational community in the field of computer science has been energetic for over three decades [4]. The general objective of education in the field of software engineering is to deliver an academically solid system to instructors [5]. The development of any part of software comprises of a human component. It requires some tasks such as problem-solving, logical thinking, communication, and psychological thinking [6]. Additionally, there are different activities involved in software development life cycle (SDLC) i.e. requirements engineering, software design, coding/implementation, testing, and maintenance.

In SDLC, the phase of requirement engineering is mostly recognized as the most difficult process [12]. In the requirements engineering process, software engineers use different sources to collect requirements from stakeholders. Software design/architecture is a high-level structure of a software system that comprises on useful system organization [13]. Writing programs to implement requirements as per defined architecture/structure arise under software implementation phase. To examine that how the system behaves according to the given input and identification of faults is called software testing [14]. Adding new features, enhancements, and modifications in the existing system are done in the software maintenance phase [15]. All the activities involved software engineering i.e. effort estimation [16], designing and architecture [17], testing [18], etc. demand specific personal having different relevant skills and abilities for fulfillment. It has been testified that numerous fresh graduates in the field of software engineering frequently face challenges while entering in their professional careers. The excellence of the software engineering personnel is a straight result of software engineering education as well as how software engineering students are skilled. In any case, there is a generally noted gap between the education that graduates get from universities and the skills that are needed by the software industry. Despite the fact, several university programs largely pay attention to the core or fundamental areas of computer science whereas the areas of software engineering do not get as much consideration. It is generally acknowledged that better tutoring of the students in the field of software engineering will set them up in an improved way to start their careers in software engineering after graduation and will expand their skills and capability. Hence, it's an ideal opportunity to endorse the extensive progress of the program of software engineering degree.

Currently, there is a wide range of software applications that are being used efficiently in almost every stage of day-to-day life

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[7]. According to this viewpoint, software engineering plays a vital role in this development. As the nature of the working environment in software industries is diverse, energetic and self-motivated, so human resources like software engineers and other important actors probably have a variety of regularly changing skills, tasks, and responsibilities [8,9]. Many software engineering jobs are posted on different job portals regularly. From this point of view, these software engineering job postings can be considered to identify market demand and skills requires by professionals [10,11].

In this paper, a survey is conducted from fresh software engineering graduates, software engineering professionals and job portals to conduct a comparison between supply (interest of fresh software engineering graduates) and demand (job openings in the software industry in specific areas/phases of software engineering by taking software experts feedback and online job portals). The purpose of this study is to guide fresh graduates in their career choices so that they can improve their skills and start their careers as per the software industry's most in-demand area. The rest of the article is structured as follows. The next section describes the literature review in this area. Section III explains our research methodology. Section IV analyzes the results of our study. Lastly, section V will provide the conclusions of the study.

2. LITERATURE REVIEW

Software engineering is an immensely energetic field. Education and training in the field of software engineering are dynamic regions among the professionals' networks and education research [19-22]. Researchers in the field of software engineering has done a lot of research to highlight the industry requirement regarding computing positions for new employees and the training being provided to the computer science students in the field of software engineering.

Keeping in mind the petition for skilled software engineers in the future, an empirical analysis based on a probabilistic generative method for topic modeling (latent Dirichlet allocation (LDA)). is conducted in [23] to provide important bits of knowledge and Influence on software engineering education. Empirical analysis has shown that the software industry has a wide spectrum regarding proficient jobs, duties relevant to popular skills, and a mix of programming languages. This study has also emphasized a comprehensive series of software engineering characteristic i.e. methodologies, skills, trends, demands, platforms and technologies, which specify the progress and growth in the software engineering field.

It is normally recommended that the courses of computer science are created in a space with a minimum or no respect for the real-world needs of the student's ultimate employer ([24], [25]). The people in the field of academics and the software industry are constantly debating on the matter of the gap between the education that is being delivered to computer science students and the industry demands regarding new workers in computing relevant fields.

A survey was conducted in the domain of information technology regarding the identification of skills and they concluded that soft skills are more needed in the industry [26]. It would be more appropriate to focus on the ability and the competence that is needed for a software engineer to work in the industry rather than to look at programs or syllabus that is being taught in universities [27]. Another research has shed light on the significance of soft skills and hard skills for the position of the fresh software engineer. This study recommends that soft skills are suggestively more vital than hard skills [28]. Still, gaps exist between what the industry demands and the skills graduates have. A study is conducted to observe the skills gap between software engineering applications and software engineering curriculum [24]. This study has identified some of the reasons that cause this gap and also suggested some possibilities to bridge the gap. The study highlighted that working in such an industry having a dynamic pattern and a fast-changing environment is the major reason for the gap. By providing an appropriate software engineering curriculum to the university and building a connection between the university and industry employees can be a solution to bridge the gap.

In [29], it is stated that practical skills are more significant for the one who has to start a career in the field of software engineering whereas non-technical skills are required or have more importance for the one who has developed the career [30]. Hence, learning for skills and knowledge is essential for software engineers during the permanency of their careers. It is the fact that there is no traditional agreement concerning essential skills mandatory for software engineers. Problems in evaluating skill status may starts from the circumstance that skill demands change as experts found their careers.

3. RESEARCH METHODOLOGY

Figure 1 depicts the different steps of our research methodology. As is evident from this figure, the first step of our research was survey of fresh graduates. The survey of professionals was the next step of our research methodology. Data collection related to software engineering jobs under different phases of the software development life cycle (SDLC) is the third step. The last step is the analysis of collected results from surveys and online job portals.

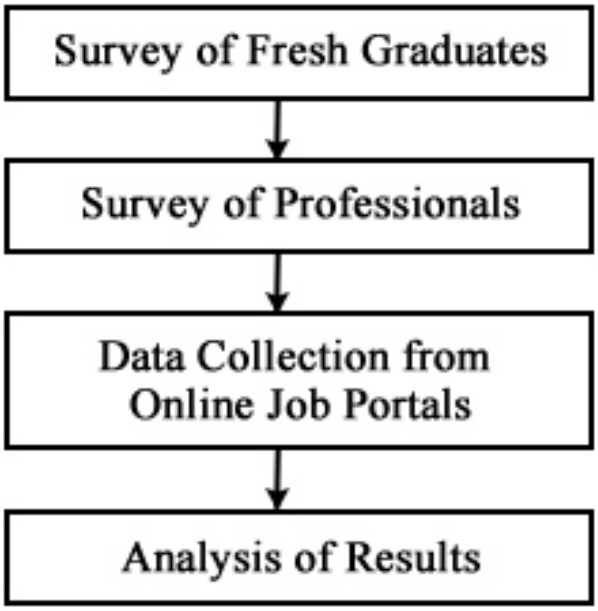

Figure 1. Research Methodology

3.1 Survey of Fresh Graduates

A survey of fresh graduates (from the private sector university of Pakistan) was carried out to know the career choices of these graduates. A total of 368 fresh graduates took part in our survey. All these were graduates of Bachelor of Science in Computer Science (BSCS) and Bachelor of Science in Software Engineering (BSSE). All these graduates enrolled in the university in the year of 2015 and passed out in 2019.

3.2 Survey of Professionals

During the second step of our research methodology, a survey of Pakistani software industry professionals was carried out. The purpose of this survey was to know that according to industry professionals which phase of software development life cycle (SDLC) has more job openings. An online survey form was circulated in industry professionals. A total of 51 professionals participated in our survey. Industry professionals were asked to submit their work experience, their role in companies, their rank in the company, and which phases of SDLC have more opportunities for fresh graduates.

Figure 2 describes the work experience of professionals. It can be seen from this figure that around 85% of respondents were having more than five years of work experience. This strengthens the reliability of our results.

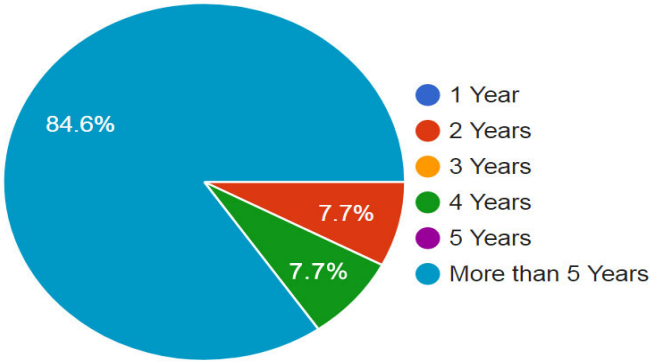

Figure 2. Work Experience of Respondents

Figure 3 shows the role of respondents in their respective companies. Around 31% of the respondents were CEOs/presidents/owners or directors of the companies which have more software industry exposure in the business perspective. Around 23% of participants were principal software engineers whereas 23% were senior software engineers. 7.7% were the HR managers in their respective companies and 23% were having anonymous designation in their companies.

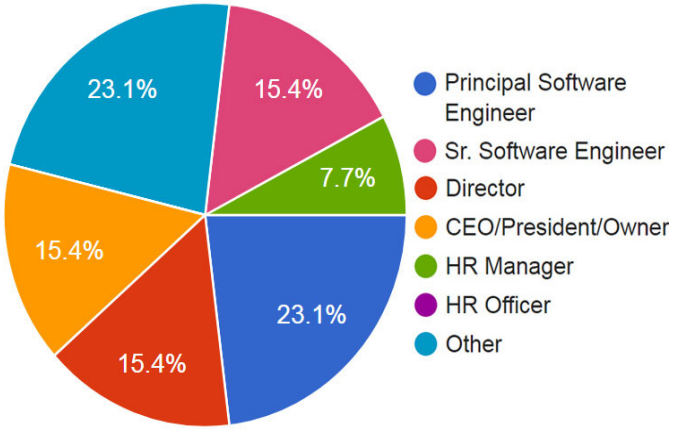

Figure 3. Role of Respondents in their Respective Companies

Figure 4 demonstrates the rank of professionals in their respective companies. It can be seen in the figure that around 61% of the participants were the project managers of the companies who leads the projects and creates new job openings in the field of software engineering.

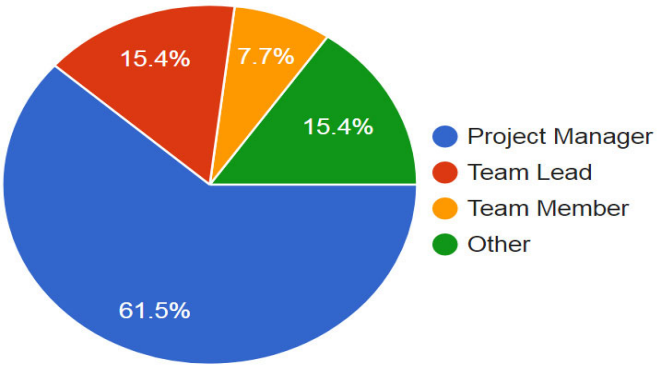

Figure 4. Rank of Respondents in their Respective Companies

3.3 Data Collection from Online Job Portals

Table 1 shows the data collected from the top three job portals of Pakistan. Column II describes the different phases of the software development life cycle (SDLC). Columns III-V show the number of job openings in three selected job portals whereas the last column shows the total job openings for each of six phases of SDLC.

Table 1. Data Collected from Top Three Selected Job Portals.

Sr #	SDLC Phases	Current Job Openings at Job Portals			
		Rozee .pk	Jobee .pk	Mustakbil .com	Total
1	Requirements Engineering	30	10	12	52
2	Software Analysis	36	50	6	92
3	Software Design	20	37	6	63
4	Software Implementation	90	25	24	139
5	Software Testing	14	21	8	43
6	Software Maintenance	10	14	6	30
	Total	200	157	62	419

3.4 Analysis of Results

Table 2 provides a summary of the results of both the surveys (fresh graduates and professionals) and online job portals. Column II shows the phases of software development life cycle (SDLC). Columns III and IV describe the career choices in different phases of SDLC made by fresh graduates in numbers and percentages, respectively. Professionals' feedback regarding job openings in different phases of SDLC is given in columns V and VI. The last two columns contain the number and percentage of job openings in the top three selected portals of results.

Figure 5 depicts the comparison between career choices and professionals' feedback. The fresh graduates have more career interest in requirements engineering whereas very few professionals suggest choosing this area as they think there are very few job opportunities available in Pakistan software Industry. The same is the case for software design and software testing. The case is opposite for software analysis, software development, and software maintenance as professionals feel that more people should come in these areas and according to them, these areas have more job opportunities.

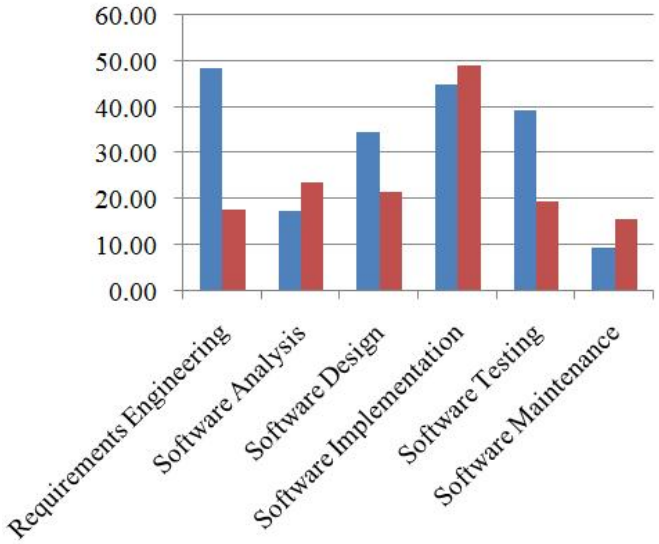

Figure 5. Comparison Between Fresh Graduates' Career Choices and Professionals' Feedback

Table 2. Results Summary

Sr #	SDLC Phases	Career Choices by Graduates		Professionals' Feedback		Portal Results	
		#	%	#	%	#	%
1	Requirements Engineering	178	48.37	9	17.65	52	12.41
2	Software Analysis	64	17.39	12	23.53	92	21.96
3	Software Design	127	34.51	11	21.57	63	15.04
4	Software Implementation	165	44.84	25	49.02	139	33.17
5	Software Testing	145	39.40	10	19.61	43	10.26
6	Software Maintenance	35	9.51	8	15.69	30	7.16

Figure 6 demonstrates the comparison between career choices and job portal results. There are few job openings in requirement engineering in the Pakistani software industry as many software houses are medium to small scale and don't hire specialized requirements engineers but many graduates have an interest in this area. Software design, software development, software testing, and software maintenance have similar results. Software analysis is the only exception where jobs are available but few graduates are interested.

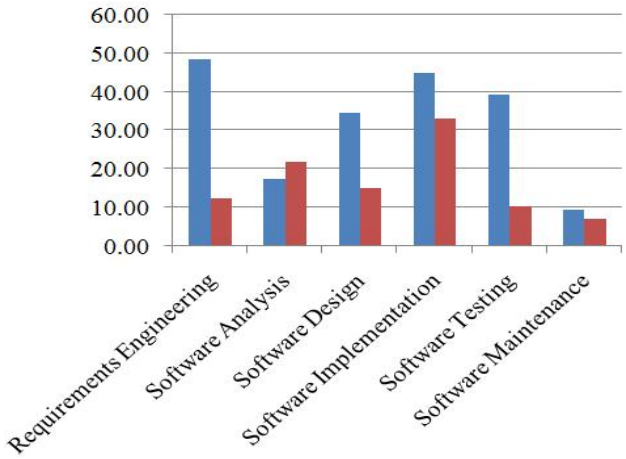

Figure 6. Comparison Between Fresh Graduates' Career Choices and Job Portals.

Figure 7 describes the comparison between professionals' feedback and job portals' results. Almost in all cases, results are the same. Professionals' feedback and industry job openings are positive relationships. Both suggest software development is the richest job area.

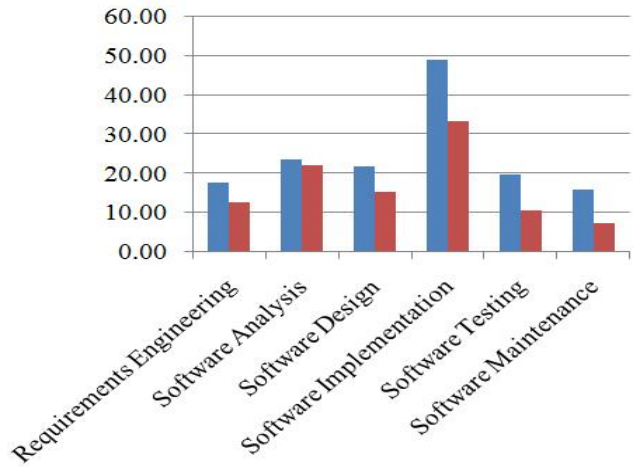

Figure 7. Comparison Between Professionals' Feedback and Job Portals.

4 CONCLUSION

In this paper, we aim to examine the needs and trends of the software engineering industry and to expose the suggestions for education in the field of software engineering. To this end, empirical analysis has been conducted by collecting the data from fresh software engineering graduates, professionals in the field of software engineering and online job portals to identify the software industry's demand and career choice of fresh software engineering graduates.

Our results show that software engineering fresh graduates are more interested in requirement engineering whereas professionals and online job portals say that there are very few job opportunities regarding requirement engineering in the

Pakistan software Industry as most of the software houses are medium to small scale and they don't hire specialized requirements engineers. Similarly, software design and software testing both are low in demand in the software industry. The case is quite different in software analysis where jobs are available, but few graduates are interested in this area. According to professionals' feedback and online job openings, people should come in areas like software analysis, software development, and software maintenance as these areas have more job opportunities in the market. As there is a positive relationship in industry job openings and professionals' feedback, so, to sum up, the discussion, software development is the most demanding job area in the software industry.

The results can provide remarkable suggestions for the software industry, academic world, and professional software engineers to fill the gap between education in the field of software engineering and industry's demand. It can also play a vital role in planning state-of-the-art syllabus for software engineering programs by keeping in mind the trends and demands of the software industry.

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