

Establishing Software Engineering as Profession in India: A Preliminary survey

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Abstract: Software Engineering besides methodical aspects deals with logistic issues, project management and human behaviour. The software industry of India is a leading hotspot for business process outsourcing and has an effervescent software industry. But the question is, are the Indian software engineering practitioners ensuing appropriate professional software engineering techniques, or, what are the challenges they are facing and what paradigm a software engineer should follow from initial education to professional practices? Comprehending the types of software engineering practices and techniques is important. To answer these questions, a survey has been carried out by the authors to understand the software engineering professional practices in India. To the best of author's knowledge, this is the first survey on professional software engineering practices carried out in India. We methodically planned an online survey with 46 questions grounded on the Software Engineering Body of Knowledge (SWEBOK) and software industry of US, Canada, Australia and UK. One hundred seven respondents; Managers, Professors, Developers, designers, Analysts, Executives and Students participated in the survey. The survey results expose significant and remarkable findings about Software engineering practices in India. They also assist in tracking the software engineering profession, and recommend capacities for upgraded education, training, and research. The results of our survey will be beneficial to software engineering professionals in India as well as world-wide by ascertaining the capacities of weakness and strength, which can inspire industry-academia associations for the excellence of software engineering.

Keywords: *Software Engineering profession; Survey; Software Engineering professional practice; Professional competence.*

Introduction

Software Engineering with methodical characteristics has to cater with logistic problems, project management and human compartment, it is an assortment of concepts, methods and tools which are required to practice frequently by a software engineer "to provide a crystal-clear view to the technical and management team regarding how the job is done

and transforms a haphazard, unfocused approach to a more organized and focused one" [1]. There should be a complete paradigm to make great software engineers "Good software engineers are essential to the creation of good software. However, most of what we know about software engineering expertise are vague stereotypes, such as 'excellent communicators' and 'great teammates'. The lack of specificity in our understanding hinders researchers from reasoning about them, employers from identifying them, and young engineers from becoming them. Our understanding also lacks breadth: what are all the distinguishing attributes of great engineers (technical expertise and beyond)?" [2]. Software engineers need also to develop personality. "Considering the importance of the effect of human factors in many aspects of software engineering, the amount of research on the effects and influences of personality in the field is relatively small. The evidence is weak and in many cases inconclusive. More research is required if we want results that can influence the practice of software development" [3]. Software engineers for successful software development requires a specific disposition of traits [4][5][6]. To establish software engineering as a profession in India, it is essential to recognize which practices would be best suited for software engineering. In order to answer the questions, a survey was conducted on software engineering practices and trials in India.

Several surveys have been conducted in USA, Australia and other countries but to the best of author's knowledge, no survey record has been found yet regarding establishing software engineering as profession in India. The motivating aspects for conducting this survey in India are:

i) In software development India is becoming a global leader. The Indian IT-BMP industry provides software artifacts, IT services, e-commerce, BMP and ER&D. The global sourcing in India is growing faster than IT-BMP. According to the reports of Ministry of Electronics & Information Technology Government of India and NASSCOM (SR-2018) global IT-BMP industry excelled 4.3% over 2016 and is at USD 1.3 trillion excluding hardware, while global sourcing in 2017 touched USD 185-190 billion growing at 1.4X. Indian IT-BMP industry in 2018 is growing closer to 8% with an increase of USD 12 billion from FY2017- FY 2018. It has grown from USD 154 billion in FY2017 to USD 167 billion in FY2018 [7][8][9].

ii) India is a major global digital solutions acquaintance, with digital economy as high as Trillion dollars due to the perseverance of government collaboration with private sector. "India has become hub for digital services. India a hotbed for digital innovation with a rich ecosystem of start-ups, tech providers, and service providers engaging in global delivery and investing in digital IP, solutions, and CoEs. India based digital providers creating impact by targeted investments across people, process, and technology. India a leading destination for delivery of digital services with 70-75% of global digitally involved FTEs based out of India"[7].

The Indian software industry providing software artifacts, engineering services, BPM and IT services. It is service oriented as well as product based, depends greatly on exports and is essentially accomplished by large number of professionals. Indian Software Industry has grown exponentially, to be persistent and to retain this performance India has to face many challenges.

In this paper we present an exploratory study on the software engineering practices, principles, and disposition of traits. We systematically deliberated an online survey with 46 questions based on the recommendations of Software Engineering Body of Knowledge (SWEBOK) and as per the standards adopted by software industry of Canada, US, Australia and UK. One hundred seventy respondents including executives, managers, students, developers, professors, designers, and analysts participated in the survey.

I. RESEARCH METHODOLOGY

This research study was navigated using qualitative research methodology. Qualitative research methodology illuminates complex social structure; helps researcher to comprehend and extrapolations.[10]. Qualitative research methodologies are best suited to understand the domain of research, to ascertain the complexity of the field and to search for the assortments[11]. Qualitative methodology is also appropriate when the field of study is novel and little is known about the context, as it accentuates on deeper procurement of information[12]. This is an online survey-based study where the respondents are asked a series of questions. The comprehensive depiction of the survey is deliberated in the following subsections.

A. Survey Objective

The survey was designed in such a way so that it could fulfill research objectives. The major objective of this survey is to establish software engineering as a profession in India, which includes ethical aspects of software engineering, application of software engineering code of ethics, criteria for choosing appropriate policy of accreditation, development of skills, gauging the competence by the application of licensing and certifications, professional development of software engineers, building of professional societies and application of theoretical framework and preliminary professional education of software engineers. The objective was to deliver a clear

view of the contemporary professional practices in Indian software development industry.

The secondary objective of this survey was to provide didactic perceptions of Indian software engineering education, which would help education sector to ascertain whether the existing curriculum on software engineering is adequate to engage engineering students with professionalism. If the curriculums are not as per professional demands, then this survey may assist to designing software engineering courses for India as per International norms. Furthermore, this survey may comfort to offer future research direction in the software engineering field by recognizing challenges of developing software.

The questionnaires and the essence of the survey were deliberated as per the hypothesis derived from above two objectives.

B. Survey Description

The survey targeted the managers, professors, developers, designers, analysts, executives, students and all those who are involved with software engineering and its practices. The questionnaires pertaining to survey are grouped in eight sections which are summarized below.

1) Section A –Demographics

This section reconnoitered the characterization of respondents in terms of their age, gender, occupation, professional expertise and qualification. Furthermore, this section also netted the role and accountabilities of the respondent.

2) Section B -Theoretical Framework and preliminary education

This section includes questionnaires related to theoretical, conceptual and foundational aspects of software engineering. This section ask questions like :Software engineering curriculum to have integrated professional practice module ; Preliminary professional education to enable software engineering graduates to design, analyze and manage development of a computing-based system, component or processes and implementing new technologies to compete in the global environment; Software Engineer to engage in continuous learning, career improvement and adopt to changing professional and societal needs ; software engineersto build software in contemporary, global, business, environmental, economic, and societal context; and Software Engineers to apply well-defined engineering practices and use software engineering knowledge, methods and abilities to classify, formulate and resolve software engineering problems.

3) Section C-Policy of Accreditation

This section explores accreditation policies of India and enquires about making institutions to be flaw conscious and thereby make improvement of the programme offered; to constantly work for the quality and excellence; to achieve

international acknowledgement of accredited degrees awarded ; to enable the movement of graduated students and professionals ; to bring Professional competence and Professional commitment ; and to sign Seoul Accord for accreditation or recognition of software engineering at global level.

4) Section D-Development of Skills

This section focusses on software engineers to have a set of skills to apply knowledge gained in preliminary professional education; to have a skill set as per industry domain; and to design software engineering curriculum as per SE 2014 guidelines.

5) Section E -Certification and Licensing

The section held the questions to ascertain that certification and licensing are two important means to assure proficiency of a professional software developer and reduces the risks of unprofessional practices; suggests India like IEEE should initiate licensing of software engineers ; ascertains that Certifications will make software engineers well equipped with requisite skills and possesses basic knowledge; emphasizes that Indian software engineer to practice its profession in international market should not only have internationally recognized degree but also internationally recognized licensure; Licensing to bring international recognition of India software engineers, as it indicates high competence; and to offer in India licensing at state level and also at national level by government agencies which then be mapped to international level.

6) Section F - Software Engineering Code of Ethics

This section emphasizes that India should actively take part in IEEE/ACM Code of Ethics and Professional Conduct (Code 2018); that a Software Engineering professional should contribute to society and to human well-being, considering implications of software on society; that a Software Engineering professionals of any organizations should not misrepresent any organization's policies or procedures, and should not speak on behalf of an organization unless authorized to do so; that a Software Engineering professional should acknowledge the work required to produce new ideas, creative works, inventions, and computing artifacts. That a Software Engineering professional should respect privacy; that a Software Engineering professional should honor confidentiality; that a Software Engineering professional should maintain high standards of professional competence, conduct, and ethical practice; that a Software Engineering professional acting as a leader should articulate, encourage acceptance of, and evaluate fulfillment of the social responsibilities of members of an organization or group.

7) Section G - Professional development

This section asks questions about professional development achieved by a professional for professional practices, with continuous education and training; that Software Engineer should stay up to date as per the evolving body of technical knowledge; that Computer societies of India should realize importance of professional development and

should take concrete steps to set up standard guidelines for professional development; that India should have well defined protocol leading to constant upgrading of knowledge and skill set of software engineers; that Renewal of licenses should be on the basis of continuous professional development; that India need to set up centralized organization for quality control and accreditation for professional development

8) Section H - Professional society

This section focuses on professional society to define criteria for licensure; to manage certification of software engineers; to develop standards for software engineering profession; to develop body of knowledge for software engineering profession; to define ethics code; to design software engineering curriculum as per international standards; to build strategies for professional development.

II. SURVEY RESULT

A) Demographics

This subsection intended to characterize the software development community in India. Questionnaires were designed to realize the job.

Respondents were asked about their profession, occupation, degree and gender by multiple-choice questions. Out of the 107 respondents, 6 are Analysts, 34 are developers, 3 are executives, 5 are managers, 24 are professors, 25 are students and 8 belong to some other profession. Figure 1 indicates that the respondents were mainly professors, students and developers.

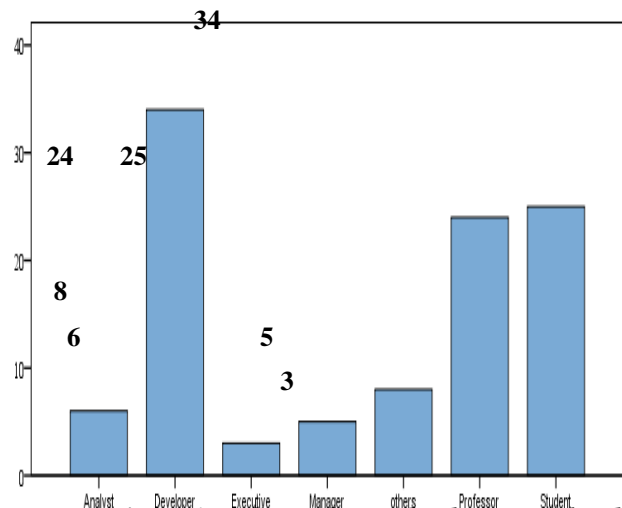


Figure 1: Indian software development related Professionals

The questionnaire was designed to target primarily researchers, educators and practitioners. Figure 2 shows out of the 107 respondents, 30 are educators, 49 are practitioners and 25 are researchers. Figure 3 shows 11 respondents which are primarily students have bachelor's degree, 11 are having master's degree, 31 are having doctorate degree and 9 are professional engineers.

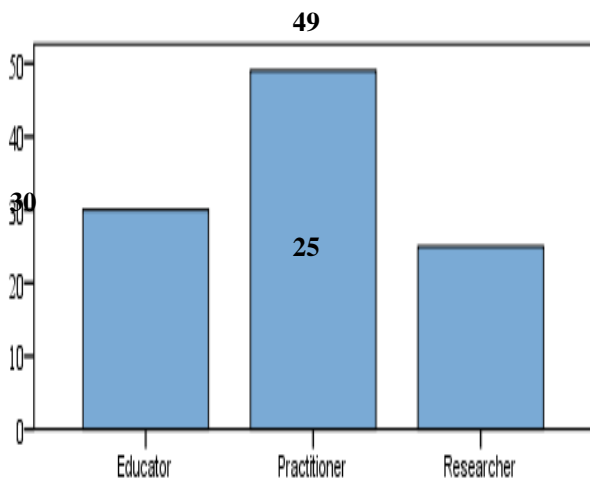


Figure 2: Primary occupation

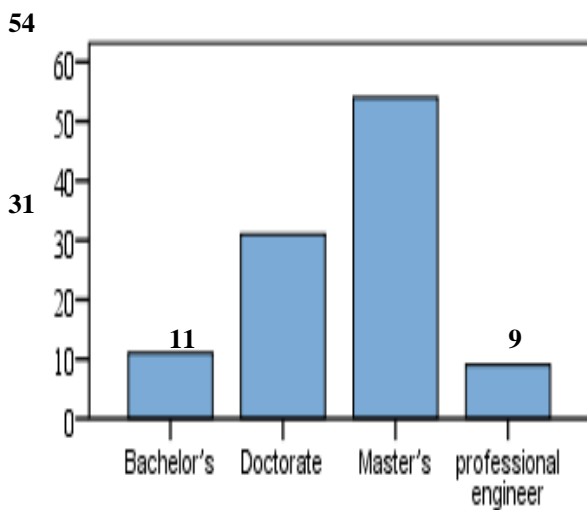


Figure 3: Degree

Occupation	Total	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
Manager	5	-	3	-	2	-
Professor	24	-	5	-	5	14
Developer	34	6	18	1	9	-
Analyst	6	1	1	1	3	-
Executive	3	2	-	1	-	-
Student	25	3	11	7	3	1
Others	8	-	1	2	4	1
Total	107	12	39	12	26	16

Table 1: Occupation Inclination toward theoretical concepts.

It is prevalent from the survey that students, developers etc. are unaware of the importance of theoretical, conceptual and foundational aspects of software engineering.

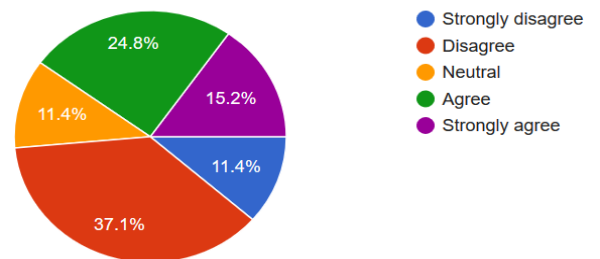


Figure 4 : Theoretical, conceptual and foundational aspects of software engineering

B) Theoretical Framework and Preliminary Education.

This section investigated theoretical, conceptual and foundational characteristics of software engineering in India. In India software engineering is grounded on application domain, more focus should be on theoretical consideration in the preliminary software engineering education. Table 1 reflects the inclination of different occupations towards the theoretical concepts.

C) Policy of Accreditation

The goal of this section was to explore and improve the accreditation policy of India, such that institutions offering software engineering:

- attain quality and excellence;
- to be flaw conscious;
- achieve international acknowledgement ;

- bring Professional competence and Professional commitment;

It was also suggested that India should sign Seoul Accord for accreditation or recognition of software engineering at global level. 62.5% of respondents agreed that India should sign Seoul Accord.

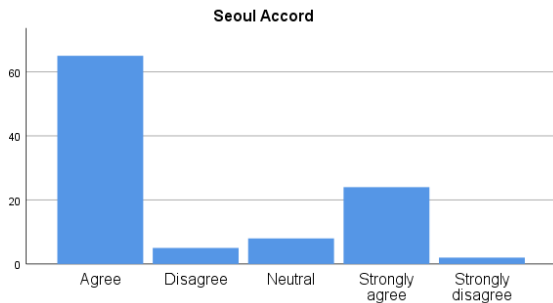


Figure 5: Seoul Accord

D) Development of Skills

This section focuses on skill set that a software engineer should possess to apply knowledge attained in introductory professional education. This skill set should be as per industry domain. It was also emphasized that Indian software engineering curriculum should be designed as per SE 2014 guidelines to meet its global requirements. The responses were as follows:

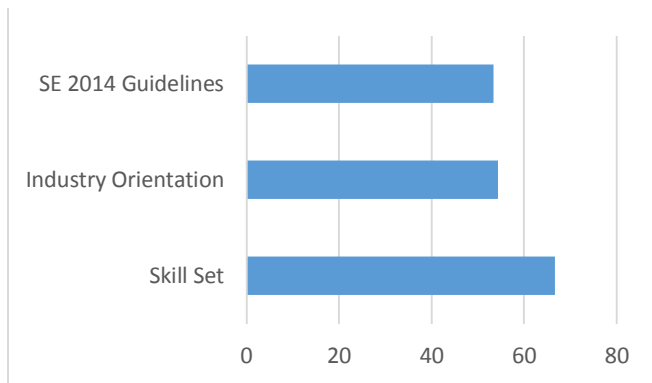


Figure 6: Development of Skills

E) Certification and Licensing

This section emphasizes on the importance of Certification and licensing as two significant means to guarantee expertise of a proficient software developer and shrinks the jeopardies of unethical practices. The survey stresses that India should start licensing of software engineers as commenced by IEEE. The survey highlighted following points:

- Certifications guaranties that software engineer is well equipped with mandatory skills and knowledge;
- Indian software engineer to work at global platform require internationally recognized license.

- Licensing will make India softwareengineers competent at international levelas it indicates high competence.

- India can commence licensing at state and nationallevel which then be plotted at international level.

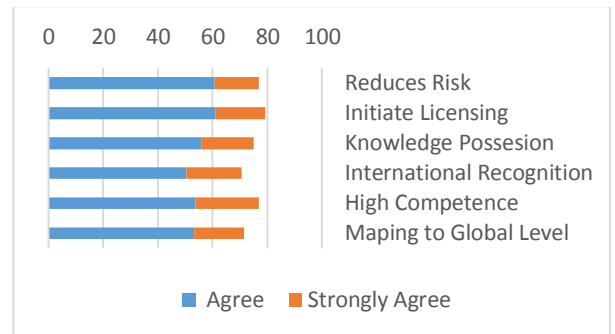


Figure 7: Response for Certification and Licensing

F) Software Engineering Code of Ethics

This Section was aimed at understanding the application and effects of software engineering code of ethics. Indian software engineers were suggested to take part actively in IEEE/ACM Code of Ethics and Professional Conduct (Code 2018); should contemplate repercussions of software on society; should not distort any organization's policies or procedures; should not represent his organization unless authorized to do so; shouldrecognize the efforts required to yieldcreative works,new ideas, inventions, and computing artifacts; should respect privacy and confidentiality; should uphold high values of professional competence, behavior, and ethical practice; should articulate, inspire acceptance of, and appraise fulfillment of the social accountabilities of associates of an association or group.

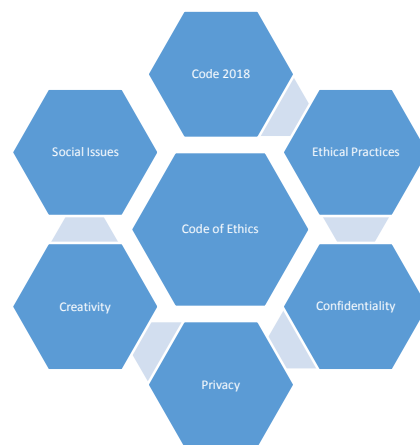


Figure 8 : Software Engineering Code of Ethics

G) Professional development

This section investigated the Professional development of software engineering professionals for professional practices, with continuous education and training. This survey essentials argues that a software engineer should stay connected with the progressing build of technical knowledge. The survey reflected realization and importance of professional development and asked for setting up standard guidelines for professional development by explicit protocols leading to persistent progression of knowledge and skill set; licenses renewal should be on the basis of continuous professional development. This survey also reiterated for creation of centralized organization for excellence control and accreditation for professional development. The response of this section stays above 61%.one

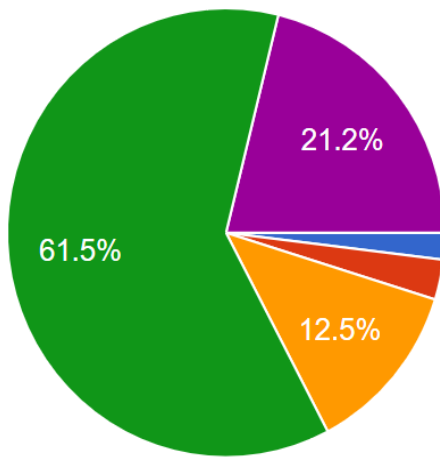


Figure 9 : Professional Development

H) Professional society

The goal of this section was to explore the dynamics of professional societies. The questionnaire of this section was designed to stress on following aspects of a professional society:

- Should delineate measures for licensure;
- should manage certification of software engineers;
- should cultivate ethics for software engineering profession;
- should advance body of knowledge for software engineering profession;
- should define ethics code;
- should strategies curriculum for software engineering as per international principles; and
- should build policies for professional development.

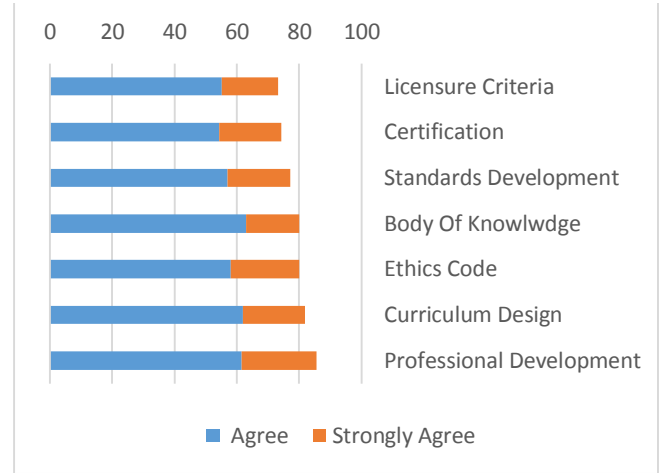


Figure 10 : Aspects of Professional Society.

III. DISCUSSION AND RECOMMENDATION

This survey provided deep valued insights regarding the professional aspects of software engineering in India. This survey showed that India is lagging in all aspects which make software engineering a professional discipline. In India Software engineering is grounded on application purview, and there is a less focus on conceptual, theoretical and foundational aspects. Software engineering curriculum in India need to have cohesive professional practice component and engineer should involve in incessant learning, profession improvement and adopt to fluctuating professional and societal prerequisites.

The insights from the survey show that for bringing professional capabilities and commitment India should sign Seoul Accord for accreditation of software engineers, which will allow global recognition of Indian software engineers, moreover software engineering curriculum should be as per SE2014 guidelines.

The authors have investigated the facts that certification and licensing guarantee proficiency; India like IEEE should commence licensing software engineers at state as well as national level. It was also reiterated that India should be a proactive part of IEEE/ACM Code of Ethics and Professional Conduct (Code 2018).

Authors on the basis of the observation also recommended that India should have unified association for excellence regulator and accreditation for professional development by having a predefined protocol for persistent promotion of knowledge and skill set of software engineers and staying par with the evolving body of technical knowledge. Authors also noted that professional societies are linchpins to implement all aspects of professionalism and has to play a decisive role for make software engineering a profession.

IV. CONCLUSION AND FUTURE WORK

This paper offered the preliminary survey on professional software engineering practises and studied the conclusions. The survey was conducted between 2017 and 2018 among 107 respondents including managers, professors, developers, designers, analysts, executives and students, the conclusions from the survey make the authors assertive to present the analysed results. The authors consider that the conclusions reveal some of the inclinations, practices and challenges of the professional software engineering in India, which will guide the government of India and the professional societies to create policies and also will help in decision making. The survey results describe substantial and noteworthy findings about Software engineering practices in India. They also assistance track the software engineering profession, and recommend capacities for upgraded education, training, and research. The results of our survey will be beneficial to software engineering professionals in India as well as worldwide by ascertaining the capacities of weakness and strength, which can inspire industry-academia associations for the excellence of software engineering.

This survey was mostly intended to investigate the professional software engineering practices in India. Thus, broader and deeper study is required to realise more insights of professional software engineering.

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