A Theory of Planned Behaviour (TPB) Based Study on the Reluctance of Sri Lankan IT Undergraduates in Pursuing a Software Quality Assurance Career

PPG Dinesh Asanka, Chathura Rajapakshe, Dilani Wickramaarachchi

Abstract— **Despite the growing demand worldwide, the popularity of the Software Quality Assurance (SQA) profession has always been questionable. Technology is increasingly being adopted in the SQA process. Still, the prospective entrants to the profession seem to doubt various aspects such as career progression, learning opportunities, social recognition, etc. This research aims to study why SQA is not a popular career choice among computing undergraduates. Specifically, it aims to unveil the critical factors that affect the reluctance of undergraduates to pursue a career in SQA. The research was conducted in Sri Lanka, a popular offshore outsourcing destination for software development. Over 500 undergraduates who follow computing degrees in state and non-state universities in Sri Lanka were surveyed using a questionnaire developed based on the theory of planned behaviour. The results were analysed using qualitative and quantitative approaches and verified at a forum of experienced quality professionals. The findings confirm that the SQA profession is perceived less favourably than other career paths, such as software development and project management in computing. The study explores different attributes related to the undergraduates' attitudes, subjective norms, and perceived behavioural control, likely impacting their reluctance to choose an SQA career. Additionally, the study explores the impact of gender, internship status, and the type of educational institution. The study concludes that 1) Lack of awareness about the SQA profession, 2) Possible inferiority complexes and ill-treatment at the workplace, 3) Effects of the negative messages the senior students carry to their juniors after internships, and 4) The impact of the alumni who work as SQA professionals are the potential areas that the industry and the academia need to work on individually as well as collaboratively to mitigate the risks stemming from the undergraduates' reluctance to join the SQA profession.**

Keywords: **Career Choice, IT Undergraduates, Software Engineering, Software Quality Assurance, Theory of Planned Behaviour**

I. Introduction

Software Quality Assurance (SQA) Engineer is an important job role in the field of software engineering. Traditionally known as software testing, this role has been continuously evolving over the years to become what it is now [1], [2]. With the recent development of computing technologies, the research has shown further potential for the SQA profession to grow through the automation of SQA practices [3], [4], [5], [6], development of better SQA tools [6], [7], [8], encompassing more SQA techniques [3], [8], [9], adoption of intelligent technologies and data analytics [5], [6], [10], etc. Moreover, the emerging systems that involve ABC, i.e. Artificial Intelligence, Big Data, and Cloud Computing, would require more advanced SQA practices [11], [12]. According to World Quality Report 2018-2019 [13], end-user satisfaction would be the top objective in the field of software testing and quality assurance in the next few years. Thus, the quality engineering career must shift from mere testing to a role that optimises the user experience and value addition by thinking like an end user and adopting emerging technologies such as artificial intelligence and machine learning to develop intelligent testing and test automation environments. Moreover, the report points out that the skills required for quality assurance and software testing have changed, and the low levels of automation and challenges with test data and environments are holding back quality assurance and software testing efficiencies [13]. Under such circumstances, the "SQA Analyst" job title has been ranked the second happiest in America in 2018 [14].

Despite such developments, the popularity of the SQA career has always been doubtful [15], [16]. Even though the reports mention many attractive opportunities in the field of SQA, companies worldwide face the issue of sourcing competent quality assurance professionals. A systematic literature review on knowledge gaps in software engineering, which considers the publications from 1995 to 2018, reports that software quality and testing could be categorised into the high importance - high gap region [17]. Moreover, many non-peer-reviewed literature (grey literature), such as online blogs, articles, and industrial sources, are also reporting a shortage of software testers [18]. Furthermore, according to the same source that quotes [19], the real challenge in the context of software testing or quality assurance is not just recruiting "quantity" (number of people available in the job market) but the "quality" software testers (i.e., with the right skill set). One possible reason for this is the reluctance of competent individuals, particularly university graduates, to pursue an SQA career.

The authors have observed for several years that undergraduates who follow computing majors are reluctant to pursue a career in SQA. Sri Lanka (where this study was done) being a popular offshore outsourcing destination for several decades, has a matured software industry and many reputed software development companies.

Moreover, the Sri Lankan software industry has set higher targets for 2025 in terms of growth and sustainability [20]. Hence, there is always a significant and growing demand for talented software professionals who are mostly sought from state-owned universities and non-state higher education

PPG Dinesh Asanka, Chathura Rajapakshe and Dilani Wickramarachchi are from the Department of Industrial Management, University of Kelaniya, Sri Lanka. (dasanka@kln.ac.lk, chathura@kln.ac.lk, dilani@kln.ac.lk).

institutes affiliated with foreign universities to award degrees [21], [22].

However, it is a common observation that undergraduate students prefer a software development career much more than an SQA career from the early years of their undergraduate studies. In fact, the software development companies, together with the universities, have made several attempts to enhance the awareness of students about the SQA profession, but still, the interest among undergraduates towards the SQA profession seems to be minimal. This has made a notable impact on the growth and sustainability of the software industry, as the quality of global software heavily depends on the quality (and quantity) of the industry's human resources.

This observation, apparently, is not different in other parts of the world. There is a series of studies conducted in Canada, China, Pakistan, Malaysia, Norway, India, Brazil, and the UAE, which confirms the fact that there is a reluctance among undergraduate students to choose an SQA career due to various common reasons [23], [24], [25], [26], [27], [28], [29]. Moreover, those studies have identified several common factors which they claim to be contributing to the unpopularity of the SQA profession. However, more research is needed for better confirmation of the factors that contribute to the unpopularity of the profession and the development of industry-academia collaborative strategies to mitigate human resource risks in the software industry. As pointed out by Rodrigo et al. [30], replication of empirical research represents an important component in the construction of knowledge in software engineering since it allows studies to be repeated, results to be cross-checked, and the validity of outcomes to be expanded to different contexts [31]. Thus, the exploration of other similar contexts, as well as cross-context comparisons, are highly essential for the progression of the SQA profession.

This paper presents the results of the first phase of a large three-phased study, which aims to answer why SQA is an ill-favoured career. In the first phase, the study investigates why SQA is not a popular career choice among undergraduates. The second phase will focus on the current SQA professionals in the industry to evaluate their current level of satisfaction in their careers. In the third phase, it is expected to devise better collaborative strategies for the industry and academia to popularise the SQA profession among undergraduates. The research questions the study attempts to answer at the end of the first phase are as follows.

1. Is SQA an ill-favoured career among computing undergraduates?
2. What factors make undergraduates reluctant to become SQA professionals?
3. What suggestions could be made to the industry and academia to mitigate the risks stemming from this reluctance?

Accordingly, the objectives of the study are 1) to investigate whether the profession of SQA is an ill-favoured career path among computing undergraduates, 2) to identify the critical factors that hinder computing undergraduates from opting for an SQA career, and 3) to discover possible collaborative actions that the industry and academia jointly can perform to mitigate the impact of this potential reluctance of choosing an SQA career.

The rest of the paper is organised as follows. Section 2 reviews the existing related literature, particularly the work done in other parts of the world. Section 3 contains the details of the research design and methodology. Section 4 presents the highlights of the key findings from the data analysis, whereas Section 5 discusses the findings. Finally, Section 6 contains the concluding remarks and future work.

II. RELATED WORK

As mentioned in the previous section, the perception of undergraduates toward an SQA career has been widely studied in other parts of the world [23], [24], [25], [26], [27], [28]. However, most research focuses on software testing rather than quality assurance. SQA is a broader term that encompasses various strategies and techniques adapted to convey a certain level of confidence in the final (software) product quality, whereas software testing is a part of quality control (QC), which refers to executing programs or applications to discover defects [4]. Moreover, according to [4], given the increase in reliance on technology, SQA has become a key area in SE since it is an umbrella activity employed throughout the SDLC. However, it is commonly observed in Sri Lanka that the two terms are used interchangeably; particularly, the term SQA is used to mean the QC activities of a software company. This observation is supported by discussions with industry partners, where it was noted that the job title "Quality Assurance Engineer" is widely used, although the corresponding responsibilities largely involve QC-related tasks, such as software testing, rather than the broader scope of SQA.

Findings in the industry, as well as among IT students, indicate that many current and future software professionals consider testing as unattractive work, and it may cause problems in recruiting and retaining testers, while low motivation can lead to poor testing and overlooking software defects [32]. In that research, they mainly address two research questions: 1) which motivational and de-motivational factors influence testing personnel in their daily activities? 2) Which strategies are applied by companies to encourage their testers? According to the results, several positive and negative factors impact the motivation of software testers. Particularly, the negative factors identified by the research are 1) lack of influence and recognition, 2) unhappiness with the management, 3) technical issues, 4) lack of organisation, 5) time pressure, 6) boredom, 7) poor relationships with developers, and 8) working environment issues. The paper further discusses several strategies to motivate software testers.

Similar studies have been conducted in many other countries, such as Canada, China, Norway, India, Malaysia, and the UAE [23], [24], [25], [26], [27], [28], [29]. A common finding from all six studies is the strongly negative attitude among students regarding software testing. Among the negative factors highlighted by the respondents are 1) tediousness, 2) less creativity, 3) status quo-related issues, 4) stressfulness, 5) boredom, and 6) less reward. Among the positive factors mentioned were 1) the importance of the job role, 2) ease of the job, 3) more opportunities available, 4) earning opportunities, and 5) learning opportunities. According to [23], the key motivational factors for them, if they are to select a software testing career, include 1) more information on the testing profession, 2) a variety of tasks for

you to feel engaged with important work, 3) more financial rewards 4) more recognition to avoid developers looking down to testers 5) opportunity to get testing experience and 6) the opportunities to be engaged with new testing methods such as test-driven development as well as test automation.

Even though the software industry in Sri Lanka is quite mature, there are few research studies on the human factors of software development, particularly software testing or quality assurance. According to one of the few publications, the challenges of the SQA profession in Sri Lankan software companies include unrealistic timelines and budgets, lower salaries compared to other professions, lack of specialised SQA professionals, migration of experienced professionals, etc [33]. Moreover, a notable recommendation from another similar study is that developers from private and government institutions with software development degrees have less testing experience [34]. Therefore, the authors suggest that quality assurance and testing should be introduced as separate subjects for students before they enter the software industry. The authors further mention that there is a lack of understanding of the use of test tools among developers and claim that it is a reason for the minimum usage of test automation, especially at small-scale software companies in Sri Lanka. The paper further stresses the need to change the software testing staff's reward structure. According to another study on the satisfaction of SQA professionals, 62% of the respondents are dissatisfied with their job [34]. However, a notable percentage of 26% of the female respondents mentioned that they were satisfied, whereas, in the case of male respondents, the percentage of satisfied respondents was as low as 5%. Moreover, the research has found that recognition, career growth opportunities, training and certifications, salary, and general perspectives on SQA are the main determinants of job satisfaction in SQA.

III. METHODOLOGY

This study was conducted primarily based on the hypothesis that the SQA is an ill-favoured career among computing undergraduates since the authors observed it over several years of their careers as academics and practitioners. Accordingly, the research was designed to take a mixed approach. Firstly, a series of open-ended discussions were performed with twelve leading software professionals with remarkable careers in the software industry to strengthen this hypothesis and build the confidence to proceed with this study. Apart from verifying the hypothesis, it became clear from the interviews that this research addresses a timely issue in the industry as there is a significant difficulty in sourcing competent SQA professionals. Those discussions were further useful as a background study where the research team was aware of emerging skill requirements in the SQA profession, possible avenues for career progression, and the common attritions existing among SQA teams and others such as development teams.

A. Primary Data Collection and the Theory of Planned Behaviour

Primary data collection was done with the aim of both qualitative and quantitative analysis to test the hypothesis and reveal the possible factors that affect the undergraduates' reluctance to choose an SQA career. A closed-ended questionnaire was designed based on the famous Theory of Planned Behaviour (TPB) [35], [36], which was introduced in 1985 by Icek Ajzen as an extension of the Theory of Reasoned Action. Since then, the theory has been applied in various domains to study how humans make choices, including the selection of a career [37], [38], [39]. According to the TPB, the wilful behaviour of an individual is dependent upon his or her behavioural intention, which is dependent upon three other constructs, namely 1) The attitude towards the said behaviour, 2) Subjective norms, and 3). Perceived behavioural controls. Fig. 1 depicts the TPB model. The attitude towards the behaviour encompasses what the individual thinks about the said behaviour [40]. For example, in disliking an SQA career, the individual might think that the SQA profession is only for those who cannot do programming. On the other hand, subjective norms are defined as the pressure a group exerts on individuals by altering their perceptions, opinions, attitudes, and behaviours [40]. In other words, it is about what the individual believes what the others think about the said behaviour. For example, an individual may believe that society thinks the SQA profession is more suitable for females than males. The last influencing factor to the behavioural intention, the perceived behavioural controls, is defined as the set of perceptions related to one's own behaviour, determined by the set of accessible control beliefs, i.e., beliefs about the presence of factors that can facilitate or prevent behavioural performance [40]. For example, a male computing undergraduate would believe that the SQA profession is not for him because he is a male.
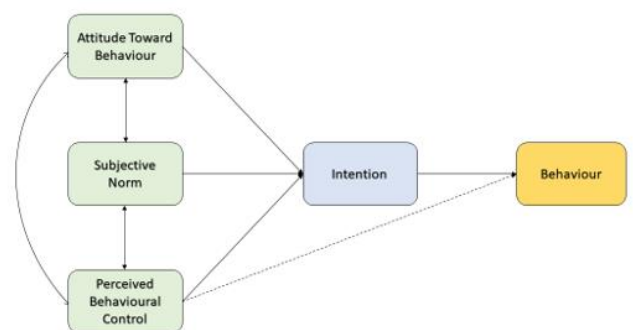

Fig. 1: The Theory of Planned Behaviour

In the closed-ended questionnaire for data collection, the intention to choose an SQA career was selected as the dependent variable. The other questions were developed based on the TPB model's three determinants of behavioural intention. Moreover, an open-ended question was added to the end of the questionnaire so that the respondents could freely express their views on the SQA profession. Apart from those questions, some preliminary questions were also asked to unveil the respondent's background, such as the key demographics and educational background.

The questionnaire was distributed online among potential respondents (i.e., those who follow computing-related undergraduate programs) in all state-owned universities and the major private higher education institutes in Sri Lanka. No particular sampling method was used, and the intention was to get as many responses as possible. Ultimately, 534 respondents had filled out the questionnaire by the time of this analysis. However, 10 responses had to be removed as bad data for various reasons. Mainly, those removed responses were from undergraduates of non-computing

degree programs; hence, they were irrelevant to the study. The male-to-female ratio among respondents was 50:50, and the percentage of responses from undergraduates in state-owned universities was 67%.

Finally, the results were presented to a group of professionals from the software industry to get their opinion on the key findings and to get the results validated at a face-to-face forum. The presentation led to an open discussion, which strengthened the findings of this research.

IV. RESULTS

The analysis of the data was done mainly using a mixed approach. As most of the questions in the questionnaire were based on Likert scales, the spider graphs were mainly used for visualisation and analysis. The responses related to the individual's attitudes, subjective norms, and perceived behavioural controls towards the intention of choosing (or not choosing) an SQA career were analysed using spider graphs. Moreover, the impact of individuals' skill levels, awareness levels, gender, and the type of institute they are studying at on their career choice was also analysed to derive the conclusions presented in this study. Apart from that, the study's findings were further strengthened using a narrative analysis [41] of qualitative responses received from the students to the last question of the questionnaire and the industry experts during the post-study presentation. The results from the narrative analysis are presented in the Discussion section.
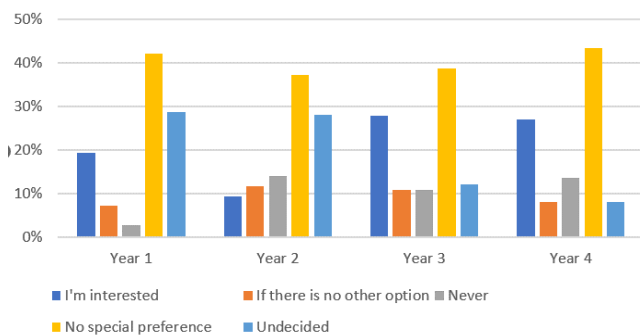
A. The Behavioural Intention

Fig. 2: Behavioural intention of respondents in different years of study

As depicted in Fig. 2 above, most respondents have said either 'interested' or 'no special preference but ready to consider', which is quite contradictory to the initial hypothesis of this study. However, a counterargument could also be built by looking at this from the other way around. Notably, 78% of the respondents are either negative or indifferent about choosing an SQA career, with a significant percentage of respondents saying either 'never' or 'yes' if there is no other option. Fig. 3 depicts a year of study-wise summary of the responses, revealing more insights.

B. Relationship with Awareness and Skills

Quite notably, the percentage of respondents who have not decided on their career shrinks when they move to higher levels of their degree programme. Moreover, there is a significant percentage of respondents who have no special preference for their career even by the time they reach their final year of study. Including that and the percentage

undecided, it is arguable that over 50% of the respondents have no 'preference' over an SQA career. In that sense, nearly 70% of the respondents were negative about the profession of SQA when they reached the end of their study programme in computing. An important question from the above observation is how much the students at different levels know about the SQA domain. Fig. 3 depicts the awareness of students of different levels of study about different careers in the software industry. Notably, there is a significant knowledge gap between the year 01/02 students and the year 03/04 students regarding SQA. Compared to the knowledge gap related to SQA, the knowledge gap related to programming and other software development-related technologies is considerably low among the two groups.
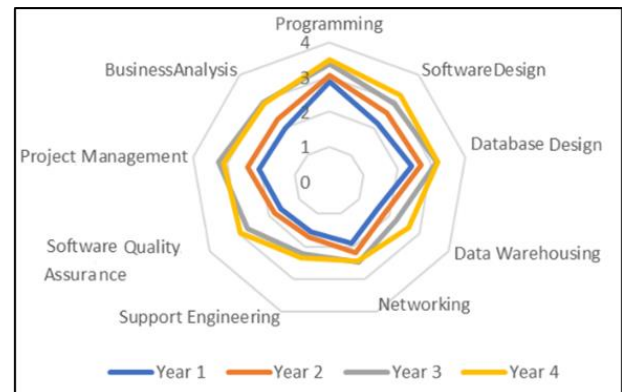
Fig. 3: Awareness of students at different levels about different Information Technology domains

Another question stemming from Fig. 3 is whether those who are aware of SQA are really aware of the full spectrum of SQA. Particularly, as the discipline of SQA has grown immensely in the recent past, the SQA profession has become more and more technology-driven and hence, technically challenging. However, according to Fig. 4, the level 03/04 students who have mentioned that they are aware of SQA are actually aware of the traditional quality control (or software testing) practices. Their awareness of emerging SQA practices and technologies is minimal. For example, though it is being adopted widely, test automation has a knowledge deficiency even among the year 04 students. Moreover, a notable knowledge deficiency exists regarding well-established practices such as load testing and performance testing.
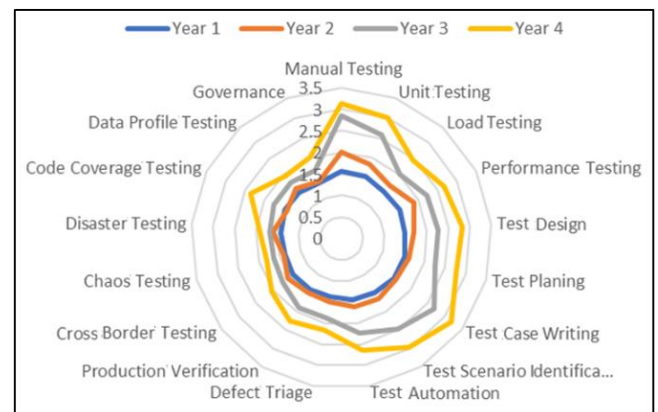
Fig. 4: Awareness of students of different SQA practices and technologies

Fig 5. indicates a possible correlation between the undergraduates' preference for pursuing an SQA career and their skill levels.
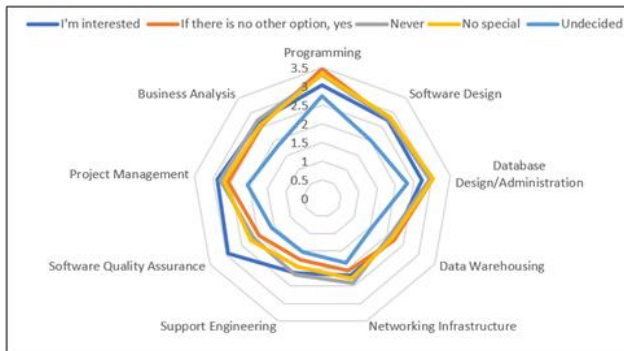

Fig. 5: Students' skill level vs. their preference

When further analysis was done, those who responded as 'Never', 'If there's no other option, yes', or 'No special preference' have higher programming skills and are apparently interested more in a software development career. On the other hand, those who responded with 'I'm interested' have fewer programming skills than the above. However, this becomes the opposite when it comes to SQA skills. Those who have responded 'I'm interested' have higher SQA skills than those who have responded 'Never', 'If there's no other option, yes', or 'No special preference'. Moreover, those who have responded 'Undecided' have comparatively lesser skills in all aspects. Thus, it could be reasonably concluded that those respondents who have responded 'Undecided' are more likely to be year 01/02 students.

C. Respondents' Attitudes and the Behavioural Intention

Respondents' attitude toward the SQA profession was evaluated over eleven potential beliefs that were identified from the literature, namely 1) QA is a less technical job role, 2) QAs get fewer opportunities to learn, 3) QA is a less challenging profession, 4) It's difficult to progress in career as a QA, 5) QAs get a comparatively lesser salary, 6) QA work mostly involves manual testing, 7) QAs have less work, 8) The industry adopts test automation rapidly, 9) QA is an important role in software development, 10) QA career is good for work-life balance, and 11) QA is given less priority compared to development. It was expected that the respondents would mostly agree with all of these eleven beliefs. However, as depicted in Fig. 6, most respondents did not agree with those common perceptions except a few. Almost all respondents have agreed that the role of SQA is important. However, those who have clearly mentioned that they are interested in pursuing an SQA career have particularly agreed withx the fact that the SQA profession has more work-life balance. Moreover, they agree with the fact that SQA mostly involves manual testing and that there is rapid growth in test automation. Furthermore, those who have responded 'Never' and 'If there's no other option, yes' have somewhat agreed with the perceptions that the SQA profession is less challenging, given less priority compared to software development, have fewer career progression opportunities, and pay fewer salaries.

D. Respondents' Subjective Norms and the Behavioural Intention

Similar to the attitudes, the respondents' behavioural norms and multiple aspects identified from the literature were also evaluated. As the subjective norms refer to what the respondents believe as what the others think, the following questions were asked in the questionnaire to see to what extent the respondents agree with them. 1) QA opportunities are very common and easy to get 2) QA profession mostly suits females 3) QA is a less technical profession 4) You should NOT become a QA if you are technically sound 5) There is no career growth as a QA professional 6) QAs earn less and learn less 7) Once QA, forever a QA 8) Those who cannot find a Dev position becomes a QA 9) QAs can relax and devote more time to other things they like (can enjoy the life) 10) Girls don't like the guys who do QA and 11) Boys prefer the girls who do QA more than those who do Dev.

Fig. 6: Respondents' attitude about the SQA profession

As depicted by Fig. 7, those who have responded 'Never' or 'If there's no other option, yes' clearly agree to the fact that those who are around them have perceptions such as 'SQA is a less technical profession', 'You should not become a QA engineer if you are technically sound', 'There's no career growth as a QA engineer', 'QA engineers earn less and learn less', 'Those who cannot find a developer position becomes a QA engineer', etc.
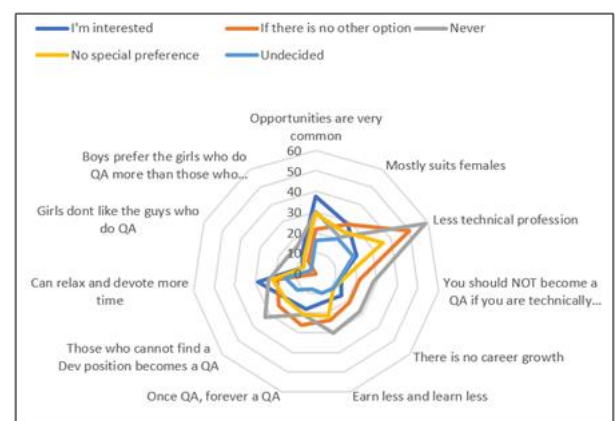

Fig. 7: Students' opinions on what those around them think about the SQA profession.

E. Perceived Behavioural Controls and the Behavioural Intention

Like the attitudes and the subjective norms, the perceived behavioural controls were also tested on a Likert scale. The identified behavioural controls, based on the literature, include a) QA is not for males as it is less technical and

rewarding, b) QA suits females more as they can spend more time on family commitments, c) QA is inferior to Dev in terms of technical expertise and growth prospects, d) QA does not suit someone who looks for career progression, e) QA becomes attractive with increasing test automation, f) QA profession is not good in terms of social recognition, g) Being a QA reflects a less technical competence, h) Software industry is changing and so as the priority of the QA profession, i) It is better to be a Dev than becoming a QA, j) Girls are good at finding faults so QA profession suits them more, k) Girls who do QA are preferred more as life partners, l) Guys who do Dev are more attractive to girls, and m) QAs cannot move into other career paths in IT easily (Once QA, forever a QA).
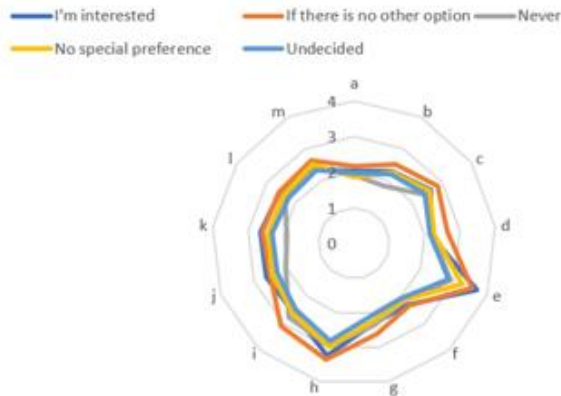

Fig 8: Students' opinion on perceived behavioural controls to join the SQA.

Fig. 8 illustrates the relationship between the perceived behavioural controls and the behavioural intention. Notably, the pattern of agreement or disagreement on the given facts by respondents is more or less the same except for a few facts. According to the graph, the points that everyone seems to be agreeing on include 1) QA is inferior to Dev in terms of technical expertise and growth prospects, 2) QA becomes attractive with increasing test automation, 3) the Software industry is changing, and so as the priority of the SQA profession, 4) Guys who do Dev are more attractive to girls and, 5) QAs cannot move into other career paths in IT easily. Moreover, a unique pattern could be observed in the respondents who said that they opted for an SQA career 'if there is no other option'. As observed in the graph, those who opt for an SQA career if there is no other option further think that 1) QA does not suit someone who is looking for career progression, 2) Being a QA reflects less technical competency, and 3) It's better to be a Dev than becoming a QA.

F. Impact of Gender

According to the results, gender is an important dimension of this study. According to Fig. 9, most who have firmly said they never opt for an SQA career are males. This is an important observation because there were equal percentages of responses from both genders. Moreover, most of those who said they would opt for an SQA career 'if there is no other option' are also male.
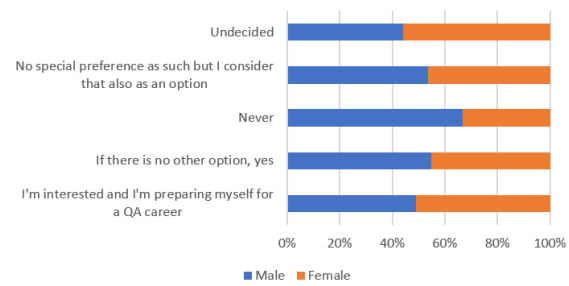

Fig. 9: Gender-based difference in behavioural intentions

Furthermore, in general, the male respondents agreed more on almost all the facts that come under attitudes and perceived behavioural controls than female respondents. However, as depicted in Fig. 9, important facts come under subjective norms where the female respondents agree more than the males. Quite notably, the female respondents strongly believe that the others think that the SQA profession mostly suits females, that SQAs can relax and devote more time to their families, and that there is no career growth in the SQA profession. On the other hand, the male students apparently think that the others believe that the SQA profession is not for technically sound and that SQA opportunities are very common.
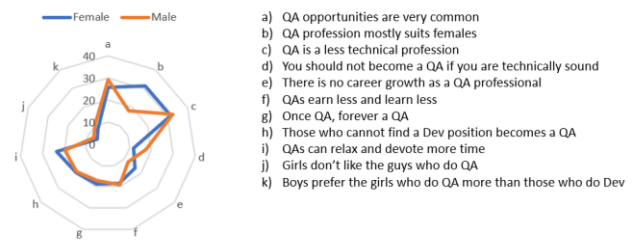

Fig. 10: Gender-based differences in subjective norms

G. Impact of the Internship

Another important insight regarding the choice of an SQA career could be found through the relationship between the behavioural intention and the internship of the respondents. The results revealed that most respondents who responded 'Never' or 'If there is no other option, yes' have already completed their internships. Moreover, a clear difference could be seen in the attitudes, subjective norms, and perceived behavioural controls among the respondents who have already completed their internships and those who have not. According to Fig. 11, there are some notable attitudinal differences before and after the internship. As seen in Fig. 11, the importance of the role of SQA, the emergence of test automation, and the potential work-life balance with the SQA profession become better known to the students after their internship. However, at the same time, they develop negative thoughts such as 'QA offers less salary' and 'QA is given less priority compared to Dev'.
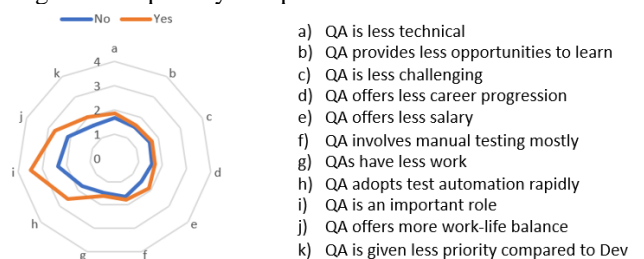

Fig. 11: Impact of internship on respondents' attitudes

Moreover, according to Fig. 12, the students become aware of various societal beliefs about the SQA profession after their internship. Notably, they hold the view that society thinks that 1) the QA profession mostly suits females, 2) QA is a less technical profession, 3) one should not become a QA if he/she is technically sound, 4) QAs earn less and learn less, 5) once QA forever a QA, 6) those who cannot find a Dev position becomes QAs, and 7) QAs can relax and devote more time to other things they like.

a) QA opportunities are very common
b) QA profession mostly suits females
c) QA is a less technical profession
d) You should not become a QA if you are technically sound
e) There is no career growth as a QA professional
f) QAs earn less and learn less
g) Once QA, forever a QA
h) Those who cannot find a Dev position becomes a QA
i) QAs can relax and devote more time to other things they like
j) Girls don't like the guys who do QA
k) Boys prefer the girls who do QA more than those who do Dev
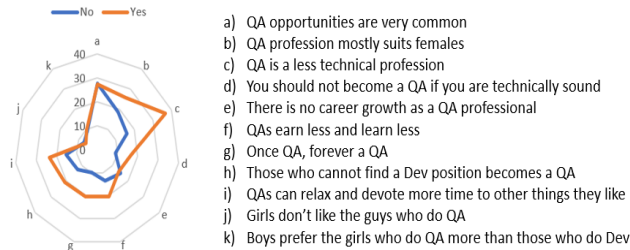
Fig. 12: Impact of internship on respondents' subjective norms

Furthermore, there are notable differences in the perceived behavioural controls of the respondents before and after their internships. According to Fig. 13, while they learn the changing priorities related to the SQA profession as well as the emerging importance of test automation, they also become (somewhat) less agreeing on views such as 1) QA is not for males as it is less technical and rewarding 2) QA suits females more as they can spend more time for family commitments 3) QA profession is not good in terms of social recognition 4) Girls are good at finding faults, so QA profession suits them more and 5) Girls who do QA are preferred more as life partners.
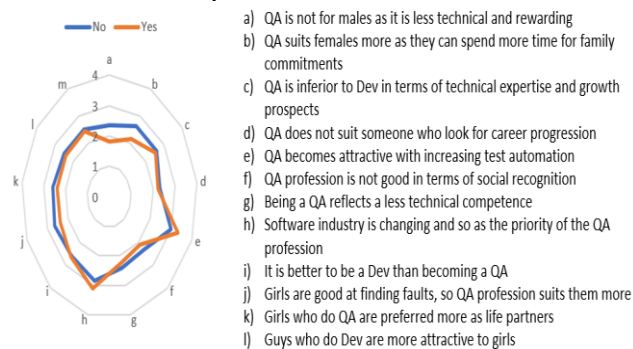

a) QA is not for males as it is less technical and rewarding
b) QA suits females more as they can spend more time for family commitments
c) QA is inferior to Dev in terms of technical expertise and growth prospects
d) QA does not suit someone who look for career progression
e) QA becomes attractive with increasing test automation
f) QA profession is not good in terms of social recognition
g) Being a QA reflects a less technical competence
h) Software industry is changing and so as the priority of the QA profession
i) It is better to be a Dev than becoming a QA
j) Girls are good at finding faults, so QA profession suits them more
k) Girls who do QA are preferred more as life partners
l) Guys who do Dev are more attractive to girls

Fig. 13: Impact of internship on the respondents' perceived behavioural controls

H. Impact of the Type of Higher Education Institute

The results also reveal an interesting difference between the state and non-state sectors. According to Fig. 14, a significantly higher percentage of undergraduates in non-state higher education institutions have responded, 'I'm interested' compared to the undergraduates of state universities. Moreover, the percentages of those who have responded 'Never', 'No special preference', 'If there's no other option, yes', and 'Undecided', representing non-state higher education institutions, are considerably lower than those from state universities. These results show a better focus among the students of non-state higher education institutions toward an SQA career.
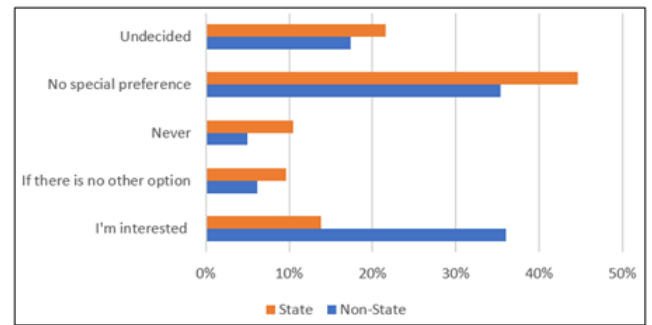

Fig. 14: Preference of respondents from state and non-state institutions

The above observation is further confirmed when comparing the responses of students representing state and non-state higher education institutions regarding SQA practices and technologies. As shown in Fig. 15, compared to the students of state-owned institutions, those from non-state higher education institutions have shown a higher awareness of almost all the traditional and emerging areas of SQA mentioned in the questionnaire. However, according to Fig. 15, the awareness of the emerging practices and technologies in SQA is low even among them.
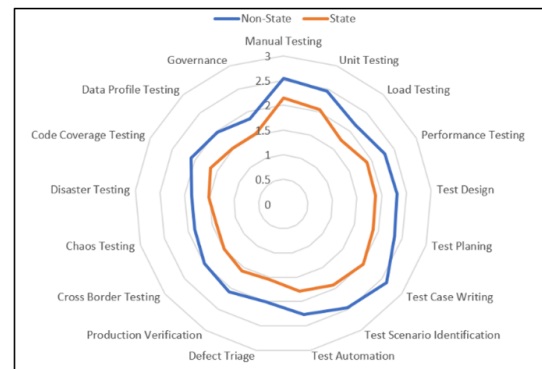

Fig. 15: Comparison of awareness of SQA techniques - state Vs. non-state undergraduates

According to the results, there is no significant difference in the attitudes and perceived behavioural controls among the undergraduates in state and non-state higher education institutes. However, when it comes to subjective norms, there are significant differences. As for what others think about the SQA profession, according to Fig. 16, the undergraduates of state universities mostly believe 1) the SQA profession is mostly non-technical, and 2) Only those who cannot find a Dev position become a QA, whereas the undergraduates of the non-state higher education institutes believe 1) SQA jobs are very common, 2) there is no career growth as QAs, and 3) QAs can relax and devote more time to other things they like.
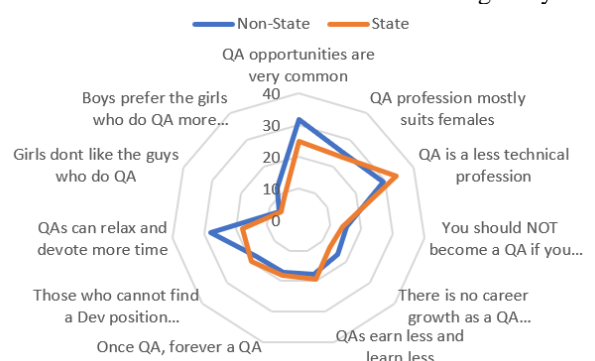

Fig. 16: Comparison of subjective norms of the undergraduates of state and non-state higher education institutions

V. DISCUSSION

The major finding regarding the undergraduates' reluctance to choose an SQA career is summarised and depicted in Fig. 17. As understood from the existing literature, there is a worldwide observation that undergraduate students generally have a negative attitude toward SQA. Hence, they are reluctant to pursue an SQA career compared to a software development career. The results of this study comply with this global pattern as a large majority of the respondents are indifferent or negative about choosing SQA as their future career. As explained in the previous section, this study has revealed some important facts which could be considered as the determinants of this reluctance.

A. Creating early awareness of the SQA profession is a must

Software quality assurance is an important aspect of software engineering. However, according to Fig. 3, the year 01/02 students' awareness of the SQA domain seems to be minimal compared to software development. From the beginning, this lack of early awareness makes them overly biased toward more visible careers, such as software development. Moreover, the lack of awareness of the emerging practices and technologies, understood from Fig. 4, also seems a critical determinant of the negative perception towards an SQA career. Notably, this issue is prevailing not only among the fresh undergraduates in year 01/02 but also among the senior (i.e., L3/L4) students, who are mostly post-interns. This also indicates a possible lack of such practices and technologies in the industry. Less awareness of the actual scope of the profession, particularly among the L3/L4 students, can make the undergraduates less interested in becoming SQA professionals, assuming that it is a non-technical and unimportant profession with fewer opportunities. A strong industry-academia collaboration is recommended to overcome this potential issue.

From the university's side, it is recommendable to enrich their curriculums, as also mentioned in [22], to give the undergraduates a better early awareness of the SQA profession and a better knowledge of the emerging practices and technologies of SQA. As one student has pointed out,

"If the University does not provide the background for SQA and doesn't encourage the students to have their future career as SQA, students will not be interested in SQA jobs".

"SQA concepts and practical knowledge are not prioritised in university curriculum as they are supposed to be (Especially the practical knowledge)."

Notably, most university curriculums give less emphasis to SQA in the first couple of years compared to other topics such as Programming, Databases, Systems Analysis and Design, Data Structures and Algorithms, and Networks. This can make students miss the point that SQA is an integral component of software engineering, equally important as programming, databases, etc. As pointed out by one professional at the validation forum,

"SQA topics could be discussed in other modules too. It need not be a dedicated module always".

On the other hand, it is recommended that the industry take long-term initiatives with the universities to groom high-quality future SQA professionals looking forward to joining the industry with much awareness and passion. This may range from awareness sessions to stronger signals indicating the importance of the SQA's role in the industry. According to one student,

"I think if undergraduates could learn about the depth of the SQA profession and the emerging opportunities in the industry, they might change their negative attitudes towards SQA careers".

One of the potentially effective strategies for the industry to enhance undergraduates' interest in the SQA profession is to assess their SQA knowledge during interviews for all software engineering positions, including developer positions. It will eventually convey to all undergraduates that the SQA role is as important as the developer role. As mentioned by another professional who was present at the validation forum,
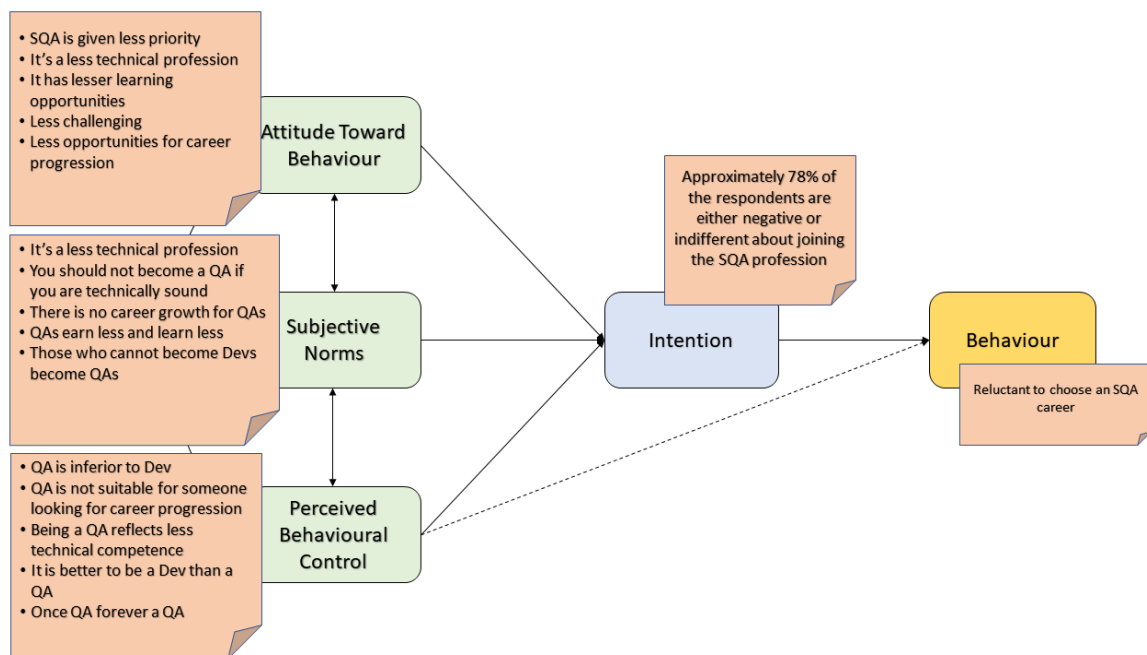

Fig. 17: Is SQA an Ill-favoured Career? - The findings

"I ask SQA questions during internship interviews. Particularly on how they used SQA when doing their final year projects."

As undergraduates are generally more receptive to messages from the industry, such actions would give them the necessary catalyst to appreciate the SQA profession better.

B. Breaking misconceptions and inferiority complexes is critical

One common misconception revealed from the results is that the SQA profession mostly suits those with less technical skills. As seen in the previous section, those with higher programming skills are not ready to consider SQA as a prospective career. In contrast, those with lesser programming skills are more interested in an SQA career. As revealed by the study, apparently, there is a common perception among students that most of those who become SQA professionals initially intend to become Devs but later change their minds because they cannot perform well in technical subjects required to become developers. As one student points out,

"Sometimes, SQAs cannot understand or properly communicate with developers because they (some but not all) do not think they should be aware of software design and development concepts, object-oriented programming concepts, etc. This is because, in most cases, those who choose SQA careers are IT graduates who don't get any other Dev opportunity. So, they are neither passionate about their work nor tend to be limited only to the SQA scope".

Even though the above is not everyone's view, such opinions seem present among student communities to a larger extent. Furthermore, such misconceptions apparently lead to some discrimination at the workplace where the SQA employees are looked down upon by the Dev employees. Apparently, this has demotivated the undergraduates to enter the SQA profession since they hear and experience such things at their workplaces during the internships. Many students have mentioned the ill-treatment of SQA engineers in the workplace. For example, as one student mentioned,

"When reflecting on the impression of computer science, SE and IT undergraduates regarding a quality assurance career, that would definitely not be the desired first option, if the career opportunity is not from a reputed company where the SQA role is highly treated".

Moreover, there seem to be contributions from work practices at organisations to this inferiority complex. Particularly, when it comes to the SQA profession, the scope of the job role and the types of testing work they have to do seem to have made the undergraduates inferior. For example, according to many students, SQA professionals are simply black-box testers since the developers themselves do code-level testing. Apparently, many companies seem to have less formalised SQA functions. For example, as one student pointed out,

"When referring to the Sri Lankan context, Sri Lankan software firms do not conduct SQA in an exploratory manner. Especially they do not have a proper testing plan; they simply get adjusted to the corresponding application".

Furthermore, having to do manual testing also seems to have discouraged people from entering the SQA profession. While most professionals agree that test automation will change the landscape of the SQA profession and its attractiveness, one professional came up with a different opinion at the validation forum.

"Test automation should not be done for the sake of doing. What is important is testing. Automation could be used as appropriate when and where it is needed".

On the other hand, societal impacts/misconceptions also seem to have impacted the reluctance to join the SQA profession. In addition to the social beliefs such as SQA being less technical, SQAs earning less and learning less, and SQA engineers having no career progression, there seems to be a gender aspect as well to the matter. As many students pointed out, there is a widely accepted belief that the SQA profession is for girls. For example, as one student mentioned,

"It is a career that society suggests as the main option for a girl seeking advice regarding a career in IT. It might be a good career, but the way they say it makes us feel like what they mean is that we can't do any better than that".

As another example, a different student mentioned developers ill-treating their SQA colleagues. Particularly, she mentioned the male SEs being sarcastic about female SQAs. Though this could also be seen as a consequence of lacking proper HR policies at some workplaces, such perceptions can significantly tarnish the impression of the SQA profession.

"To be frank, in my opinion, the software developers sometimes treat SQA colleagues with very less priority, and sometimes look down in a sarcastic view if the SQA developer is a "girl" (Some of my friends have experienced verbal harassment from male SEs)"

C. Interns potentially carry a negative message to their juniors

As it was apparent in the previous section, the post-intern impression of the undergraduates about the SQA profession is unhealthy. Moreover, there is a clear difference between the impressions of the pre- and post-intern students on the subjective norms about the profession. As interns typically spend at least 6 months at a workplace, their impression of what others think about the SQA profession is more likely to be shaped by what their colleagues at the respective workplaces think. Besides, such perceptions are more likely to be shaped based on what they experience daily than what they hear during awareness sessions. Therefore, they return to the university after internships with a strong opinion about IT careers based on their first-hand experience. This could be very influential to the mindset of their junior colleagues who plan their future careers. As undergraduates commonly consult senior colleagues to seek opinions on academic and career-related matters, the impressions of seniors about different job roles in IT are very likely to be transferred to the juniors easily. Hence, if the impression of seniors regarding a particular profession is negative, it could seriously impact the interest and motivation of juniors to consider that profession. On the other hand, when such seniors join the industry with negative impressions of a particular profession, they also knowingly or unknowingly contribute to making their interns carry the same message to their juniors. Apparently, the SQA profession has gotten caught in this vicious cycle of transferring negative impressions to undergraduates. Awareness could be created effectively only in the presence of interest and motivation. Hence, it is recommended that software companies take

action to break this vicious cycle by relooking at the work practices and reward structure of their organisations.

D. Does having an SQA alumni impact the career choice positively?

From the results, it was clear that there is a clear difference in the interest in joining the SQA profession between undergraduates in state and non-state universities and higher education institutions. Moreover, as a percentage, the knowledge of non-state university students about every aspect of the SQA profession is significantly higher compared to the undergraduates of the state universities. This interesting finding contradicts the authors' observation of academics in the state university system. The important question is what makes such a difference in the motivation and knowledge among state and non-state university undergraduates. Obviously, there is a possibility of differences in the curriculum, teaching approaches, career focus, and mechanisms to create better early awareness, compared to state universities. However, another significant possibility is the impact of the alumni, who may not be that negative towards the SQA profession. In other words, positive alumni may inspire the juniors to pursue a career in SQA more confidently. It is recommended that academia investigate this observation further, not only from the curriculum and teaching perspective but also from the social perspective involving non-state university alumni.

VI. CONCLUSIONS

This research explored three questions: 1) Is SQA an ill-favoured career among computing undergraduates? 2) What factors make undergraduates reluctant to become SQA professionals? 3) What suggestions could be made to the industry and academia to mitigate the risks stemming from this reluctance? The results of the study revealed that there is a significant reluctance among undergraduates to pursue an SQA career. Moreover, it revealed that several factors affect undergraduates' reluctance, which are related to the individual's attitudes towards the SQA profession, their beliefs on what others around them think about the profession, and their perceived behavioural controls. Moreover, a significant impact of gender, the status of the internship, and the type of higher education institute of the study were also observed on the undergraduates' career choices. As mentioned in the discussion, 1) Lack of awareness about the SQA profession, 2) Possible inferiority complexes and ill-treatment at the workplace, 3) Effects of the negative messages the senior students carry to their juniors after internships, and 4) the Impact of the alumni who work as SQA professionals were identified as the potential areas that the industry and the academia need to work individually as well as collaboratively to mitigate the risks stemming from the undergraduates' reluctance to join the SQA profession.

VII. FUTURE WORK

This study's immediate future work involves analysing data using the PLS-SEM approach. This analysis is planned to be conducted as a complementary study to strengthen the study's findings presented in this paper. The second phase of the study is about to begin, which aims to explore the satisfaction of the current SQA professionals in the industry. The rationale here is that the satisfaction (or the dissatisfaction) of the currently employed SQA professionals could impact the profession's overall attractiveness (or unattractiveness). Through the results of the first and second phases, it is expected to move into more action-oriented research in the third phase to devise collaborative strategies to popularise the SQA profession.

REFERENCES

[1] Ravichandran, S., Padmanabhan, K., & Shareef, P. M. (2007). Software quality assurance (SQA): Current and emerging trends. International Journal on Intelligent Electronic Systems, 1(1), 31–35. https://doi.org/10.18000/ijies.30006

[2] ReQtest, "An Evolution from Software Quality Assurance to Test Engineering," 2019. [Online]. Available: https://reqtest.com/testing-blog/evolution-from-software-quality-assurance-to-test-engineering/. [Accessed 22 03 2022].

[3] Mahmood, W., Shaharyar Rizvi, S., & Munir, S. (2021). The emerging role of academia in SQA. International Journal of Engineering and Manufacturing, 11(3), 28–34. https://doi.org/10.5815/ijem.2021.03.03

[4] Wambua, A., & Maake, B. M. (2022). Characterizing Software Quality Assurance Practices in Kenya. International Journal of Software Engineering and Computer Systems, 8(1), 22–28. https://doi.org/10.15282/ijsecs.8.1.2022.3.0093

[5] Uğur-Tuncer, G., Davutoglu, C., & Durakbasa, N. M. (2020). Intelligent test automation for improved software quality assurance. Lecture Notes in Mechanical Engineering, 614–624. https://doi.org/10.1007/978-3-030-62784-3_53

[6] World quality report 2022/23 | research & insight | capgemini. (n.d.-a). https://www.capgemini.com/insights/research-library/world-quality-report-wqr-2022/

[7] Hynninen, T., "Development Directions in Software Testing and Quality Assurance," University of Technology LUT, Lappeenranta, Finland, 2023.

[8] Mishra, A., & Otaiwi, Z. (2020). DevOps and software quality: A systematic mapping. Computer Science Review, 38, 100308. https://doi.org/10.1016/j.cosrev.2020.100308

[9] Ramanathan, S., "What's new in software testing," 2022. [Online]. Available: https://www.virtusa.com/perspectives/article/2022-software-testing-trends. [Accessed 20 02 2023].

[10] E. Holmala, "Guiding software quality assurance activities through data analytics: Case M-Files," Tampere Univ., Tampere, Finland, 2022. [Online]. Available: https://trepo.tuni.fi/handle/10024/143605 (accessed on 20 11 2023).

[11] Towey, D., & Yang, S., Ying, Z., Zhou, Z. Q., Chen, T., (2019). Learning by Doing: Developing the Next Generation of Software Quality Assurance Professionals. In proceedings of the International Conference on Open and Innovation Education (ICOIE), 2019, pp. 347-355.

[12] Zhang, Y., Pike, M., Towey, D., Han, J. C., & Zhou, Z. Q. (2022). "Preparing future SQA professionals: An experience report of metamorphic exploration of an autonomous driving system". 2022 IEEE Global Engineering Education Conference (EDUCON). https://doi.org/10.1109/educon52537.2022.9766791.

[13] World quality report 2019/20 | research & insight | capgemini. (n.d.-a). https://www.capgemini.com/insights/research-library/world-quality-report-wqr-2019/

[14] "The CareerBliss Happiest and Unhappiest Jobs of 2018," 2019. [Online]. Available: https://www.careerbliss.com/blog/the-careerbliss-happiest-and-unhappiest-jobs-of-2018. [Accessed 02 07 2022].

[15] Capretz, L. F., Basri, S., Adili, M., & Amin, A. (2020). "What malaysian software students think about testing?" Proceedings of the IEEE/ACM 42nd International Conference on Software Engineering Workshops. https://doi.org/10.1145/3387940.3392167

[16] Capretz, L. F., Nassif, A. B., & Harous, S. (2021). "Perceptions about software testing among UAE software students". 2021 IEEE/ACM 13th International Workshop on Cooperative and Human Aspects of Software Engineering (CHASE). https://doi.org/10.1109/chase52884.2021.00024

[17] Garousi, V., Giray, G., Tuzun, E., Catal, C., & Felderer, M. (2020). "Closing the gap between Software Engineering Education and industrial needs,". IEEE Software, 37(2), 68–77. https://doi.org/10.1109/ms.2018.2880823

[18] F. de Lima, L., Peres, L., Grégio, A., & Silva, F. (2020). A systematic literature mapping of Artificial Intelligence Planning in software testing. Proceedings of the 15th International Conference on Software Technologies. doi:10.5220/0009829501520159, pp. 1105-70.

[19] Baker, J., "2018s software engineering talent shortage— it's quality, not just quantity," 2019. [Online]. Available: https://hackernoon.com/2018s-software-engineering-talent-shortage-itsquality-not-just-quantity-6bdfa366b899. [Accessed 02 07 2022].

[20] "Sri Lanka IT-BPM Industry: State of The Industry 2019/20," 2021. [Online]. Available: www.slasscom.lk/reports/. [Accessed 02 07 2022].

[21] D.Manawadu, C., Gapar Md Johar, M., & Perera, S. S. N. (2015). Essential Technical Competencies for Software Engineers: Perspectives from Sri Lankan undergraduates. International Journal of Computer Applications, 113(17), 27–34. doi:10.5120/19920-2071.

[22] "Employability skills survey," 2018. [Online]. Available: https://slasscom.lk/wp-content/uploads/2019/10/Survey-on-employablility-skills-2018.pdf. [Accessed 10 03 2023].

[23] Waychal, P., Capretz, L., Pardeshi, S. (n.d.). Analyzing popularity of software testing careers in Canada. 2018 ASEE Annual Conference ; Exposition Proceedings. doi:10.18260/1-2--29802.

[24] Javed, A. (2012). How to improve software quality assurance in developing countries. Advanced Computing: An International Journal, 3(2), 17–28. doi:10.5121/acij.2012.3203.

[25] Fernando Capretz, L., Waychal, P., Jia, J., & B. Basri, S. (2021). Comparing the popularity of testing careers among Canadian, Indian, Chinese, and Malaysian students. Proceedings of the 3rd International Conference on Advanced Information Science and System. doi:10.1145/3503047.3503091.

[26] Deak, A., Stålhane, T., Cruzes, D. (2013). Factors influencing the choice of a career in software testing among Norwegian students. Artificial Intelligence and Applications / 794: Modelling, Identification and Control / 795: Parallel and Distributed Computing and Networks / 796: Software Engineering / 792: Web-Based Education. doi:10.2316/p.2013.796-032.

[27] Waychal, P., Capretz, L. (n.d.). Why a testing career is not the first choice of Engineers. 2016 ASEE Annual Conference & Exposition Proceedings. doi:10.18260/p.27201.

[28] Capretz, L. F., & Gilal, A. R. (2022). What Pakistani Computer Science and Software Engineering Students think about software testing? 2022 29th Asia-Pacific Software Engineering Conference (APSEC). doi:10.1109/apsec57359.2022.00087.

[29] Capretz, L. F., Nassif, A. B., & Harous, S. (2021). "Perceptions about software testing among UAE software students". 2021 IEEE/ACM 13th International Workshop on Cooperative and Human Aspects of Software Engineering (CHASE). https://doi.org/10.1109/chase52884.2021.00024.

[30] de Magalhães, C. V., da Silva, F. Q., Santos, R. E. (2014). Investigations about replication of empirical studies in software engineering. Proceedings of the 18th International Conference on Evaluation and Assessment in Software Engineering. doi:10.1145/2601248.2601289.

[31] Souza, R. E., de Souza Santos, R. E., Capretz, L. F., de Sousa, M. A., de Magalhães, C. V. (2022). Roadblocks to attracting students to software testing careers: Comparisons of Replicated Studies. Communications in Computer and Information Science, 127–139. doi:10.1007/978-3-031-14179-9_9.

[32] Deak, A., Stålhane, T., Sindre, G. (2016). Challenges and strategies for Motivating Software Testing Personnel. Information and Software Technology, 73, 1–15. doi:10.1016/j.infsof.2016.01.002.

[33] Dias, P.K., Bandara, D., "Analysis of Software Quality Assurance Profession in Sri Lankan IT Industry," University of Moratuwa, Sri Lanka, 2015.

[34] Jayasekara R.S., "Factors Affecting Job Satisfaction of Software Quality Assurance Professionals," Department of Computer Science and Engineering, University of Moratuwa, Sri Lanka, 2017.

[35] Ajzen, I., From intentions to actions: A theory of planned behavior, Springer Berlin Heidelberg, 1985.

[36] Ajzen, I.,"The theory of planned behavior," Organizational behavior and human decision processes, vol. 50, no. 2, pp. 197-211, 1991.

[37] Arnold, J., Loan-Clarke, J., Coombs, C., Wilkinson, A., Park, J., & Preston, D. (2006). How well can the theory of planned behavior account for occupational intentions? Journal of Vocational Behavior, 69(3), 374–390. doi:10.1016/j.jvb.2006.07.006.

[38] Mishkin, H., Wangrowicz, N., Dori, D., & Dori, Y. J. (2016). Career Choice of Undergraduate Engineering Students. Procedia - Social and Behavioral Sciences, 228, 222–228. doi:10.1016/j.sbspro.2016.07.033

[39] Moore, R., & Burrus, J. (2019). Predicting Stem Major and career intentions with the theory of planned behavior. The Career Development Quarterly, 67(2), 139–155. doi:10.1002/cdq.12177.

[40] Services, O., "Models and Mechanisms of public health - Development of Theory of Planned Behavior," [Online]. Available: https://courses.lumenlearning.com/suny-buffalo-environmentalhealth/chapter/development-of-theory-of-planned-behavior/. [Accessed 16 03 2023].

[41] Ethar Al-Saraf, "Narrative Analysis 101: Everything you need to know to get started" [Online], March 2023, Available: https://gradcoach.com/narrative-analysis/