E-QSE - Empirical Studies for Quantum Software Engineering

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ABSTRACT

We propose the 1st edition of the workshop on Empirical Studies for Quantum Software Engineering (E-QSE) to be co-located with the next edition of EASE 2024. Quantum Programming has been increasingly recognized in recent years, with a growing consensus among researchers and practitioners that this emerging technology has the potential to significantly reshape the landscape of computation. The workshop's objective is to foster a community where both researchers and practitioners can engage in discussions about novel ideas and share fresh insights on Empirical Studies in Quantum Software Engineering, with the ultimate goal of addressing previously unsolved problems.

KEYWORDS

Empirical Software Engineering, Quantum Software Engineering, E-QSE, Quantum Computing, Quantum Software Development.

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1 MOTIVATION

The advent of quantum computing is poised to revolutionize the field of computer science. The "quantum era" is on the horizon, offering the potential to transform program computation to the extent that solving NP-complete problems might become achievable. Leading software companies, including IBM, Google, and others, are investing substantial sums—amounting to hundreds of billions of dollars—to pioneer innovative hardware and software tools, aiming to attain quantum supremacy and embrace this transformative shift.

Despite this, the widespread development of large-scale pure quantum software systems is still in its infancy. Consequently, there is a growing interest in the creation of hybrid Quantum-Based Software Systems (QBSs), where quantum components are seamlessly integrated into traditional software applications. However, the development of QBSs poses significant challenges. These challenges include a shortage of multidisciplinary skills, limited support from programming languages, the absence of integrated development environments, and the lack of a cohesive development community. As a result, there is a rising focus on the nascent research field of quantum software engineering. This field aims to define methods, practices, and tools that support the development of QBSs, addressing the complexities and hurdles associated with this innovative approach.

As the landscape of quantum computing continues to unfold, the need for empirical studies in quantum software engineering becomes increasingly crucial. While theoretical frameworks lay the groundwork, empirical studies provide the practical insights necessary to navigate the complex challenges inherent in developing Quantum-Based Software Systems (QBSs). These studies can shed light on the real-world effectiveness of various methodologies, tools, and practices, offering valuable data to inform the refinement of quantum software engineering approaches. Empirical research plays a pivotal role in addressing the existing challenges such as the shortage of multidisciplinary skills and the absence of cohesive development communities. By conducting rigorous empirical studies, the quantum software engineering community can build a solid foundation of knowledge, fostering innovation, and accelerating the realization of large-scale, reliable quantum software systems.

To this end, we propose a workshop that focuses on Empirical Studies for Software Engineering, with the aim of attracting researchers to this research field and creating a community in which share and discuss new ideas, as well as start new collaborations.

1.1 Objectives

The aim of the workshop is to provide a forum for researchers and practitioners to present and discuss empirical studies for quantum software engineering. We expect that the workshop will help with:

- providing researchers with a comprehensive understanding of the current state of quantum software engineering;
- defining key terms, challenges, and opportunities in the field;
- analyzing case studies to understand the practical implications of implementing quantum components in software applications;
- encouraging participants to share their experiences and insights regarding challenges faced in quantum software engineering;
- discussing the strengths and limitations of different quantum programming technologies;
- discussing the synergies and challenges of combining classical software engineering practices with quantum approaches;
- developing a roadmap for future research directions in quantum software engineering.

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1.2 Intended audience

The intended audience for our workshop will likely include (i) software developers with a background in classical software engineering interested in transitioning or incorporating quantum components into their applications; (ii) professionals actively involved in the development of Quantum-Based Software Systems that are interested in gaining practical insights and empirical research skills to enhance their projects; and (iii) professors, researchers, and students involved in computer science, quantum computing, or software engineering that are looking to explore empirical research in quantum software engineering as part of their academic pursuits.

By catering to a diverse audience with varying levels of expertise and backgrounds, the workshop can foster collaboration, knowledge exchange, and the development of a robust community dedicated to performing empirical studies in quantum software engineering.

1.3 Topics of Interest

Topics of interest include, but are not limited to, the following:

- Studies on the effectiveness of different development methodologies for quantum software;
- Definition and evaluation of software metrics for quantum programs;
- Empirical studies on testing methodologies for quantum software;
- Studies on integrating quantum components into classical software applications;
- Assessment of tools supporting quantum software development, including simulators, optimizers, and debuggers;
- User studies to understand the experience of software engineers working with quantum programming languages and tools;
- Case studies of quantum software engineering projects in industry settings;
- Investigation into the cognitive aspects of designing and developing quantum software;
- Lessons learned and challenges faced during the development and deployment of quantum software applications.

1.4 Relevance

Our workshop is relevant to the EASE community for several reasons.

First, the workshop places a strong emphasis on empirical studies, aligning with the goals of the EASE community. Additionally, the workshop focuses on a novel and innovative field: quantum software engineering. This pioneering area provides an opportunity to explore how evaluation and assessment methodologies traditionally used in classical software engineering can be adapted to address the unique challenges of quantum software.

As quantum software tools introduce new programming languages and interfaces, the workshop explores usability and user experience evaluation which aligns with the broader EASE goals.

By encouraging a multidisciplinary approach, the workshop brings together quantum computing experts and software engineers. This cross-disciplinary interaction contributes diverse perspectives and approaches, enriching the broader field of software engineering evaluation and assessment.

1.5 Context

The landscape of quantum software engineering has gained significant recognition within the broader software engineering community, as evidenced by the inclusive stance of major conferences and events like ICSE, ASE, and FSE. These prominent platforms actively welcome research studies in quantum software engineering, underscoring the growing importance of this transformative field. Within this context, the International Workshop on Quantum Software Engineering (Q-SE), [1] held in conjunction with ICSE, stands out as the premier event, providing a focal point for researchers and practitioners. Additionally, thematic events such as the International Conference on Quantum Software (QSW) [2] and the Quantum Software Engineering and Technology Workshop (QSET) [3] contribute to the vibrant discourse in this burgeoning field.

As organizers deeply immersed in the quantum software engineering domain, we have already chaired both the editions of the International Workshop on Quantum Programming for Software Engineering (QP4SE) [4] co-located with ESEC/FSE in 2022 and 2023. Furthermore, our engagement extends to serving as guest editors for a special issue [5] in the journal "Science of Computer Programming". This collective involvement underscores our commitment to fostering collaboration and advancing the state of knowledge in quantum software engineering.

2 ORGANIZATION

2.1 Details on the Organizers

All the organizers have a background on Software Engineering and Quantum Programming.

Fabiano Pecorelli is a postdoctoral researcher in the Jheronimus Academy of Data Engineering (JADE lab) research group at the Jheronimus Academy of Data Science (JADS), and Eindhoven University of Technology, the Netherlands. He received a bachelor's, master's, and P.h.D. degree in computer science from the University of Salerno, Italy. His research interests include software code and test quality, predictive analytics, mining software repositories, software maintenance and evolution, empirical software engineering, and quantum software engineering. He serves and had served as a referee for various international journals in the field of software engineering (e.g., TOSEM, EMSE, JSS). Contact him at f.pecorelli@jads.nl. More info at https://fabiano-pecorelli.github.io.

Maria Teresa Baldassarre is Associate Professor at the University of Bari, Italy, and member of the Software Engineering Research Laboratory (SERLab). Her research interests are: empirical software engineering, human factors in software engineering, quality assessment and, recently, quantum software engineering. She collaborates on several research projects within small and medium enterprises.

[1] https://conf.researchr.org/home/icse-2024/q-se-2024
[2] https://conferences.computer.org/qsw/2023/
[3] https://qserv.spilab.es/q-set-home/
[4] https://sites.google.com/view/qp4se/home
[5] https://www.sciencedirect.com/journal/science-of-computer-programming/about/call-for-papers#quantum-programming-for-software-engineering

She is a partner of the SERandPractices spin off company of the University of Bari. She is actively involved in research projects and collaborations with international partners. Currently she is the representative of the University of Bari in the International Software Engineering Research Network (ISERN), and is involved in various program committees related to relevant software engineering and international empirical software engineering venues.

Manuel A. Serrano is M.Sc. and Ph.D. in Computer Science by the University of Castilla-La Mancha. Associate Professor at the Escuela Superior de Informatica of the Castilla-La Mancha University in Ciudad Real. Regarding his research interests, he is working on quantum computing, quantum software engineering and cybersecurity. His-scientific production is large, having published more than fifty papers in high level journals and conferences. He has participated in more than 20 research projects, have conduct several invited speeches and have work in several transfer project with companies. He has been teaching for more than two decades at the University, especially in Software Engineering and Programming subjects and has supervised several final degree theses, final master works and PhD theses. Contact him at Manuel.Serrano@uclm.es.

2.2 Workshop Program Committee

The program committee members will be chosen from both senior and junior researchers working on the workshop's topics in order to ensure high review quality and, at the same time, support the integration of junior researchers in the community. The composition of the workshop program committee has not been defined yet and it will be finalized in case of approval of this proposal. Nonetheless, we have already informally invited 9 potential program committee members receiving positive replies about their availability. Below we report their names and affiliations.

(1) Manuel De Stefano, Cineca, Italy
(2) Ignacio García-Rodríguez de Guzmán, Universidad de Castilla - La Mancha, Spain
(3) Indika Kumara Weerasingha Dewage, Jheronimus Academy of Data Science
(4) Valeria Pontillo, Vrije Universiteit Brussel, Belgium
(5) Dario Di Nucci, University of Salerno, Italy
(6) Arif Ali Khan, University of Oulu, Finland
(7) Tommi Mikkonen, University of Jyväskylä, Finland
(8) Macario Polo, Universidad de Castilla - La Mancha, Spain
(9) Luis Jimenez Navajas, Universidad de Castilla - La Mancha, Spain

3 WORKSHOP FORMAT

The workshop will be held in one day with a number of sessions varying with respect to the number of accepted papers. The workshop will start with an opening session, in which the organizers will introduce the event and its schedule. The opening session will be followed by a keynote speech given by a topic expert.

Anticipating an engaging and collaborative atmosphere, we expect to welcome approximately 20 to 30 active participants to the workshop. This count encompasses workshop chairs, session chairs, and authors of accepted papers, creating a diverse and knowledgeable gathering. Given the workshop's co-location with the main event, we also anticipate additional participation from individuals securing full registrations for the overarching conference. This dual opportunity not only enhances the workshop's reach but also provides a platform for a broader spectrum of attendees to contribute to the vibrant discussions and knowledge exchange in the dynamic field of quantum software engineering.

The workshop necessitates the availability of a projector along with a laptop for seamless presentations. In the event that a laptop shouldn't be available, rest assured that one of the workshop chairs will be equipped to provide their laptop as a contingency, ensuring that all participants have the means to effectively present and share their valuable work. This proactive approach is intended to facilitate a smooth and inclusive experience for all workshop attendees.

3.1 Paper Selection Procedure

The workshop will consider two different types of submissions: regular papers, and short papers.

- Regular papers will be up to 10 pages and will report original empirical research quantum software engineering;
- Short papers will be up to 5 pages and will discuss visions, novel ideas, and experience reports on quantum software engineering.

All accepted papers will be part of the EASE 2024 proceedings under the copyright of the ACM digital library.

3.2 Paper Evaluation Process

In adherence to the main conference guidelines, our workshop will follow a comprehensive paper revision process.

All papers will be subjected to a thorough peer review process, with a focus on originality, quality, soundness, and relevance. The workshop will use a double-blind review process, with three members of the program committee reviewing each submitted paper.

Our review process will be following the same criteria of the main conference, namely:

- **Soundness:** The extent to which the paper's contributions and/or innovations address its research questions and are supported by rigorous application of appropriate research methods;
- **Significance:** The extent to which the paper's contributions can impact the field of software engineering and under which assumptions (if any);
- **Novelty:** The extent to which the contributions are sufficiently original with respect to the state-of-the-art;
- **Verifiability and Transparency:** The extent to which the paper includes sufficient information to understand how an innovation works; how data was obtained, analyzed, and interpreted; and how the paper supports independent verification or replication of the paper's claimed contributions;
- **Presentation:** The extent to which the paper's quality of writing meets the high standards of EASE, including clear descriptions, as well as adequate use of the English language, absence of major ambiguity, clearly readable figures and tables, and adherence to the formatting instructions provided above.

3.3 Workshop Deadlines

Below, important dates for first submission, notification, camera-ready, and early registration are reported:

- Papers submission: March 8th, 2024
- Papers notification: April 12th, 2024
- Papers camera-ready: April 26th, 2024
- Early registration deadline: May 5th, 2024

3.4 Publicity Plans

To encourage people to attend our workshop, we'll send out a call for papers to mailing groups in the software engineering and quantum programming communities. We will also create a Twitter account and a Facebook Page that we will use to publicize the workshop and reach as many researchers as possible. Additionally, we will set up a website reporting all the most important information of the workshop.

As a final outcome, we expect to receive 10 to 20 submissions and to have around 30 registered attendees. All EASE 2024 participants are welcome to attend the workshop. To assist in the wide dissemination of the accepted contributions as well as the discussion among the participants, we will nominate a person in charge of public relations and content dissemination during the workshop.

TENTATIVE CALL FOR PAPERS

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- Case studies of quantum software engineering projects in industry settings;
- Investigation into the cognitive aspects of designing and developing quantum software;
- Lessons learned and challenges faced during the development and deployment of quantum software applications.

In line with the main conference call for papers, we welcome papers employing any of the following empirical methods in SE:

- Action Research; Benchmarking
- Case Study;
- Case Survey;
- Data Science;
- Engineering Research (aka design as research, design science);
- Experiment with human participants;
- Grounded Theory;
- Longitudinal Study;
- Meta-science;
- Mixed Methods (also select methods that were mixed);
- Optimization Studies;
- Qualitative Survey (i.e., interview study);
- Quantitative Simulation;
- Questionnaire Survey (quantitative);
- Repository Mining;
- Systematic Literature Review;
- Mixed methods and multi-methodology;
- Replication studies.

E-QSE also welcomes studies with negative findings or non-significant results.

How to submit

All papers must be submitted in PDF format through EasyChair. Page limit will be 10 for regular submissions and 5 for short papers, including all figures, tables, references, and appendices.

All submissions should use the official ACM Primary Article Template (https://www.acm.org/publications/proceedings-template). Deviating from the ACM formatting instructions may lead to a desk rejection.

Authors must comply with the SIGSOFT Open Science Policy, https://github.com/acmsigsoft/open-science-policies/blob/master/sigsoft-open-science-policies.md (i.e., to archive data and artifacts in a permanent repository—e.g., Zenodo, not GitHub—to the extent ethically and practically possible, and include links in a Data Availability section in their manuscripts).

E-QSE 2024 will employ a double-anonymous review process. Do not include author names or affiliations in submissions. All references to the author's prior work should be in the third person. Any online supplements, replication packages, etc., referred to in the work should also be anonymized. Advice for sharing supplements anonymously can be found here

https://ineed.coffee/post/how-to-disclose-data-for-double-blind-review-and-make-it-archived-open-data-upon-acceptance

By submitting to E-QSE, authors agree to the ACM Policy and Procedures on Plagiarism, Misrepresentation, and Falsification https://www.acm.org/publications/policies/plagiarism-overview. Papers submitted to EASE must not be published or under review elsewhere. The Program Chairs may use plagiarism detection software under contract to the ACM. If the research involves human participants/subjects, the authors must adhere to the ACM Publications Policy on Research Involving Human Participants and Subjects https://www.acm.org/publications/policies/research-involving-human-participants-and-subjects.

Review criteria

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- **Verifiability and Transparency:** The extent to which the paper includes sufficient information to understand how an innovation works; how data was obtained, analyzed, and interpreted; and how the paper supports independent verification or replication of the paper's claimed contributions;
- **Presentation:** The extent to which the paper's quality of writing meets the high standards of EASE, including clear descriptions, as well as adequate use of the English language, absence of major ambiguity, clearly readable figures and tables, and adherence to the formatting instructions provided above.

Important Dates

- Papers submission: March 8th, 2024
- Papers notification: April 12th, 2024
- Papers camera-ready: April 26th, 2024
- Early registration deadline: May 5th, 2024

Conference Attendance Expectation

If a submission is accepted, at least one author of the paper is required to register for the conference and present the paper. In case a student is the only author registered for the conference, a full fare registration must be paid.