Qeios

Peer Review

Review of: "A Review of Formal Methods in Quantum Circuit Verification"

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My overall verdict: **a weak survey with limited scholarly value**. Here's why, point by point.

What the paper does

It covers barrier certificates, abstract interpretation, model checking, theorem proving, and runtime verification as applied to quantum circuit verification, with brief sections on applications (QEC, compilers, algorithms) and challenges. It's 23 pages, including a very long reference list.

The core problems

1. It adds essentially nothing new. The paper's own reference list undermines its novelty claim. The paper itself cites Chareton et al. (2022), "Formal Methods for Quantum Programs: A Survey" — a well-established, comprehensive prior survey that already covered this ground in far greater depth. The given paper does not explain *how* it differs from or advances beyond that work, nor from the Lewis, Soudjani & Zuliani (2021/2022) survey on arXiv:2110.01320, which is also in the references.

2. It's extremely shallow. Each major section (barrier certificates, abstract interpretation, model checking, theorem proving) runs roughly one to two pages. There are no formal proofs, no worked examples, no quantitative comparisons of tools, and no empirical evaluation. The "case studies" amount to one paragraph each, with no actual data.

3. Suspicious self-citation. Two of the 83 references are papers by the same author: Govindankutty et al. (2023), "Rotational Abstractions for Verification of Quantum Fourier Transform Circuits," and Govindankutty & Srinivasan (2025), "Superposition-Based Abstractions for Quantum Data Encoding Verification." These are cited in the section on model checking/theorem proving, yet the survey body

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gives no additional coverage of this work compared to other cited papers. This smells like using a survey to boost citation counts for prior work.

4. The "tools" table (Table 2) is dubious. The paper lists tools like "QECVerifier," "QuaVer," "QVVerify," "HQVer," and "PulseVerifier" without any primary citations for them. Several of these names do not appear in the reference list and are not readily verifiable in the literature. This is a significant red flag — a survey should never list tools without citations.

5. Structurally generic. The "challenges and limitations" and "future directions" sections are almost entirely generic — scalability is hard, quantum features are tricky, tool support is immature, hybrid methods and ML-assisted verification look promising. These observations appear verbatim in every other survey in this area and offer no new insight.

7. Notable omissions. The paper barely touches several important and active areas: ZX-calculus-based verification, equivalence checking (a huge subfield with tools like QCEC by Burgholzer & Wille), stabilizer-based methods, symbolic execution frameworks like symQV, or automata-based verifiers like AutoQ. These are all well-represented in the serious literature.

Is there anything of value?

The paper does try to give extra prominence to **barrier certificates** as a verification technique — this is a somewhat less-surveyed angle, and if that section were substantially deeper, it could be a niche contribution. But at two pages, it doesn't deliver on that promise either.

The reference list (83 entries) is reasonably current, including 2025 papers, so it could serve as a quick bibliography dump for someone new to the area — but a bibliography is not a survey.

Bottom line

This reads like a master's-level literature summary written quickly to put something on a CV. It is not a rigorous survey, does not advance the field, contains potentially fabricated tool names, and is outclassed by multiple existing surveys it cites without adequately distinguishing itself from them. I would not recommend citing it or treating it as an authoritative reference.

Declarations

Potential competing interests: No potential competing interests to declare.