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De-Risking Healthcare Digital Transformation: Automated QA for SAP S/4HANA

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Abstract

This article presents an analytical synthesis of approaches to de-risking the digital transformation of healthcare organizations based on SAP S/4HANA through automated quality assurance. The study is conducted as a systematic analysis of peer-reviewed scientific sources and focuses on interpreting the quantitative effects of test automation in terms of change controllability rather than solely development efficiency. Particular attention is paid to measurable indicators of release speed, test coverage, system recovery resilience, and behavioral predictability under frequent updates, as well as to their role in forming managed quality control loops. It is shown that the key factor of transformation sustainability is the extent to which critical quality-assurance risk areas—related to test authoring, maintenance, execution, and result formalization—are addressed, rather than the mere presence of automated test scripts. It is established that, in the healthcare context, the applicability of automation is determined by its integration into the computer system validation lifecycle and change-control processes that ensure requirements traceability and test reproducibility. The analysis demonstrates that the highest level of sustainability is achieved in models where test automation is embedded within a formalized quality-management framework and used as a mechanism for preventing risks associated with digital change. The article is of interest to researchers in digital health, enterprise information system architects, quality and validation specialists, and practitioners involved in transforming SAP landscapes in regulated environments.

Keywords: *Digital Transformation, Healthcare, Automated Quality Assurance, Risk Management, Computer System Validation.*

INTRODUCTION

Digital transformation in the healthcare sector is accompanied by a sharp increase in the complexity of managerial and clinical-administrative processes, intensified regulatory control, and elevated responsibility for the continuity of medical care provision [2]. Under these conditions, enterprise resource planning systems, including SAP S/4HANA, become the central element of medical organizations' operational activity, ensuring financial accounting, supply management, patient settlements, and other critically significant functions. Any errors in such systems or failures during their modification directly affect process stability, financial sustainability, and patient safety, turning software change quality into a systemic risk factor.

However, traditional approaches to quality assurance based on manual control and limited automation prove insufficient for operating under conditions of frequent updates, complex integrations, and a high cost of error [7]. Major risks shift from individual functional defects to the loss of change controllability, increased inspection labor intensity, and reduced trust in testing results. In response to this, automated quality assurance for SAP S/4HANA is viewed not as an auxiliary technical tool, but as a purposeful mechanism for reducing digital transformation risks in healthcare, ensuring release stability, change predictability, and controlled compliance with critically important requirements.

The aim of the study is to develop and substantiate an analytical framework for de-risking digital transformation in the healthcare sector based on automated quality assurance for SAP S/4HANA, combining quantitative indicators of intelligent test automation, industry quality assurance risk zones, and regulatory requirements for computerized system validation. To achieve this goal, the article addresses the following tasks:

Identify and systematize key operational and qualitative risks arising during the digital transformation of healthcare organizations based on SAP S/4HANA, with a focus on quality assurance and testing processes.

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Evaluate the quantitative effects of automated quality assurance regarding coverage indicators, test execution accuracy, maintenance labor intensity, and impact on change implementation cycles as tools for reducing transformation risks.

Compare automated quality assurance results with computerized system validation requirements and a practical implementation example in the healthcare sector, showing how test automation can be embedded into a regulatorily sustainable change and quality management model.

The research hypothesis posits that automated quality assurance embedded in the SAP S/4HANA validation lifecycle acts as a means of increasing testing efficiency and as a systemic mechanism for reducing operational, regulatory, and organizational risks of digital transformation in the healthcare sector, manifesting in measurable improvements in change implementation quality and stability.

The scientific novelty of the study lies in viewing quality assurance for SAP S/4HANA in the healthcare sector as a tool for reducing digital transformation risks, and not merely as a means of optimizing development processes. The work proposes linking quantitative automated testing indicators with the industry risk structure and computerized system validation requirements, which allows treating testing results as elements of a managed risk loop. Additionally, the analysis includes practical data from a healthcare project confirming the applicability of this approach in a regulated environment.

MATERIALS AND METHODS

The study is conducted in the format of an analytical synthesis of scientific and applied publications dedicated to quality assurance, risk management, and computerized system validation in regulated industries with a focus on the digital transformation of healthcare organizations based on SAP S/4HANA. The methodological basis is formed by comparing formalized automated testing indicators, industry quality assurance risk models, and regulatory requirements for information system lifecycle management.

Source selection was carried out considering their thematic relevance to test automation, change management, and regulatory sustainability tasks, as well as the presence of reproducible methodological approaches and quantitative indicators. The analysis is based on studies presenting indicators of end-to-end automated testing and test scenario adaptation labor intensity, including completeness, execution accuracy, and the share of manual modifications, as shown in the work of Júnior et al. [2]. To systematize quality assurance risk sources, an industrial problem classification covering test development, maintenance, execution, and result analysis stages, proposed by Ricca et al. [7], was used. Quantitative effects of test automation in change implementation processes, including reduced inspection time, decreased recovery time, and increased change delivery stability, were analyzed based on approaches considered in the material by Naqvi and Baqar [5]. The regulatory foundation of the study is formed on materials regarding computerized system validation describing the lifecycle, mandatory artifacts, and change management procedures presented by Raja et al. [6].

Digital transformation risk reduction within the study is viewed as a managed process evaluated through a set of measurable indicators reflecting change stability and quality assurance process reliability. Such indicators include testing time, failure recovery time, change implementation frequency, defect detection and leakage rates, and test coverage completeness, used for the quantitative assessment of change process stability; these indicators are substantiated by Yao et al. [10]. The effectiveness of end-to-end automated testing is evaluated using test scenario generation and execution indicators, including element and step completeness, execution accuracy and completeness, and the share of manual modifications in test scenarios, in accordance with the methodological approach of Júnior et al. [2].

To form a risk-oriented analysis structure, quality assurance risk categories related to test development, maintenance, execution, and result analysis are used, allowing for the localization of quality controllability loss sources during digital transformations; this classification is based on the review by Sapundzhi et al. [8]. The regulatory loop of the study relies on principles of computerized system validation, including requirements for documentation, requirement traceability, and change management, which are viewed as a key mechanism for preventing inspection non-conformities and regulatory violations in the healthcare sector.

RESULTS

During the study, it was established that when implementing and developing SAP S/4HANA in healthcare organizations, key digital transformation risks manifest primarily at the level of release controllability and quality assurance processes, rather than as isolated functional defects. The obtained results are analytical in nature and based on the systematization of quantitative indicators presented in the studied sources, without conducting independent experimental measurements. The recorded changes reflect the influence of automated quality assurance on change stability parameters, including implementation speed, inspection completeness, system recovery stability, and release frequency. Quantitative effects are presented in Table 1.

Table 1. Quantified impact of AI-driven test automation (Compiled by the author based on source: [5])

Metric	Baseline	AI-driven	Effect
Testing lead time	45–48 h	12–13 h	–71–75%
Test coverage	80–87%	95–98%	+15–18%

Defect detection rate	85–87%	95%	+8–10%
MTTR	24–30 h	7–10 h	–67–71%
Deployment frequency	3 / week	7 / week	+133%
Bias errors	12%	4%	–67%

Analysis of the presented indicators demonstrates that changes are systemic in nature and affect multiple release management loops simultaneously. A substantial reduction in testing time forms a different rhythm of change and reduces the density of unresolved defect accumulation between releases, which is particularly important for complex corporate systems with high module coupling. The growth of coverage completeness to near-total levels indicates a shift in control from individual functions to end-to-end processes, where errors manifest at stage and role boundaries [2]. Within the study, this is viewed as reducing the risk of structural defects characteristic of integrated systems, which corresponds to the logic of end-to-end testing and automatic scenario generation from requirements.

The reduction in recovery time after failures reflects the impact of automation beyond the release preparation stage. This indicator is interpreted as an indicator of system behavior predictability under deviation conditions and as a measure of operational loop stability, not just test quality as such. The simultaneous growth in change implementation frequency and reduction in error share indicates that delivery acceleration is not accompanied by a loss of controllability but is combined with strengthened change control. Such dynamics align with computerized system validation requirements for reproducibility and formalized lifecycle management, where release stability is viewed as part of regulatory reliability.

Within the study, separate attention is paid to the measurability of effects from automatic generation of end-to-end test scenarios from requirements formulated in natural language. For SAP S/4HANA class systems used in healthcare, regression testing acts as the main limiter of change speed due to high process coupling and strict inspection completeness requirements. In this logic, it is not the fact of automatic test generation itself that is analyzed, but the ability of such an approach to ensure reproducible completeness, accuracy, and execution stability indicators with a minimal volume of manual intervention. E2E scenario generation is viewed as an operational mechanism for accelerating regression and simultaneously controlling business process inspection completeness.

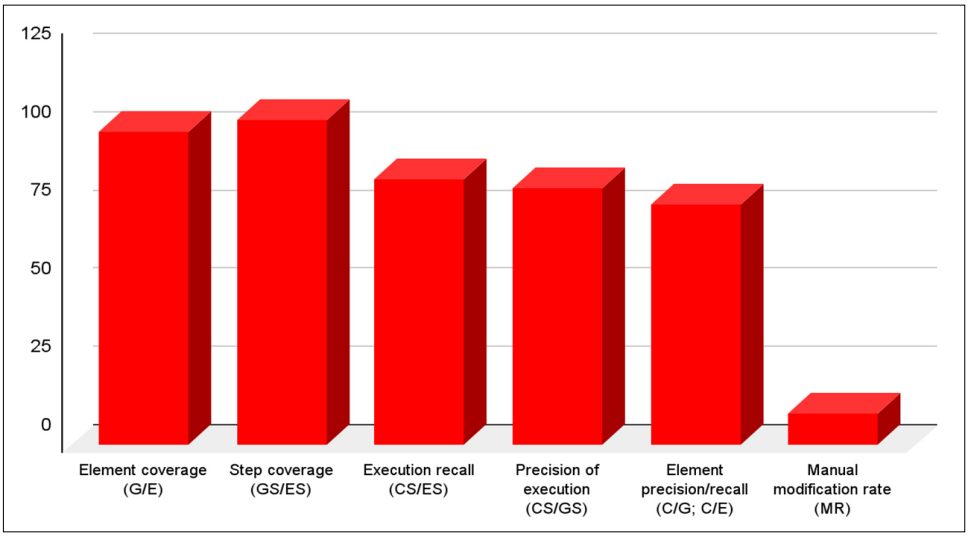

Figure 1. Key GenIA-E2ETest Metrics for Automated QA (Compiled by the author based on source: [2])

The indicators presented in the diagram demonstrate a high degree of formalizability and controllability of the end-to-end test scenario generation and execution process. Element coverage completeness reaches 100%, and step completeness exceeds 100%, indicating the pipeline's ability to identify and formalize all expected actions and additionally introduce verification steps implicitly embedded in scenarios. Execution completeness and accuracy indicators are at the level of 82–85%, testifying to stable scenario reproducibility in industrial application and a limited number of execution errors. Element identification accuracy and completeness values at the level of 77% reflect the main technical limitation zone related to dynamic interfaces and element mapping ambiguity; however, these limitations do not lead to overall coverage degradation. The low share of manual edits at the level of 10% confirms that the main load of requirement interpretation and scenario formation is transferred to the automated loop. This reduces regression testing dependence on manual labor and increases test set scaling predictability. In the context of SAP landscapes, this means shifting control from manual scenario preparation to formalized verification of holistic processes, which aligns with change controllability requirements.

Scenario execution accuracy and completeness indicators

allow viewing E2E script generation as a tool for controlling regression completeness as release frequency grows. Under conditions of accelerated change cycles, such indicators become an operational alternative to sample testing, which demonstrates limited ability to identify defects at process boundaries [5]. At the same time, the analyzed metrics do not substitute regulatory requirements but form a quantitative basis for their fulfillment through step traceability and inspection repeatability.

The aggregate of E2E scenario generation and execution indicators within the study is viewed as a tool for quantitatively describing the acceleration of regression testing and inspection completeness control under healthcare digital transformation conditions, where automation is integrated into a managed change risk reduction loop rather than functioning as an isolated technological practice.

DISCUSSION

Interpreting the obtained results in the context of corporate information systems shows that main quality assurance problems during SAP S/4HANA transformations are distributed unevenly and form stable risk zones. Not individual execution errors, but systemic violations at test preparation, maintenance, execution, and result formalization stages prove most vulnerable. Under conditions of complex integrations and high update frequency, precisely these areas become accumulation points for operational and regulatory risks directly influencing change controllability and healthcare digital transformation stability.

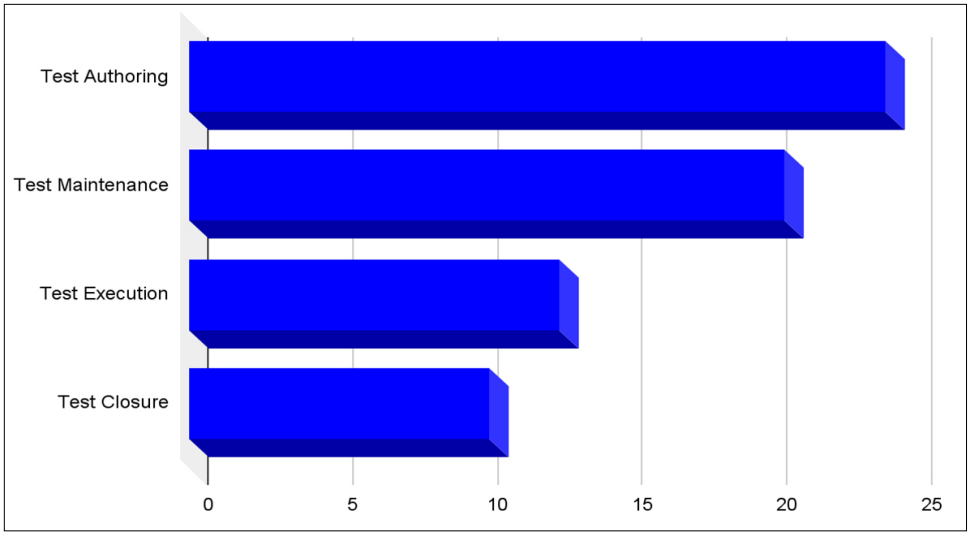

Figure 2. Dominant QA Risk Areas (Test Authoring, Maintenance, Execution, Closure) (Compiled by the author based on source: [7])

The distribution of dominant risk zones confirms that main sources of quality controllability loss form before and after the actual test execution stage. This means that increasing scenario execution stability without eliminating authoring, maintenance, and result formalization risks does not lead to systemic transformation risk reduction. Thus, automation not embedded in the full quality management loop is capable of only locally improving indicators but does not ensure digital change stability. The next significant risk zone is related to test maintenance. In corporate landscapes, this problem manifests as a gradual loss of test scenario relevance, growth in manual adjustment volume, and reduced trust in regression inspection results. Within the discussion, this area is viewed as the main point of quality controllability loss, since it is here that the conflict between change speed and traditional approach capabilities becomes most pronounced.

Test execution stage problems are conditioned not so much by scenario errors themselves as by their operation instability under complex user interface and integration link conditions [7]. For SAP landscapes, this is expressed in the growth of non-reproducible failures and difficulty in interpreting inspection results, directly influencing the validity of update release decisions. The final area related to test result fixation and analysis, despite a smaller share, has substantial significance for controllability, since insufficient artifact formalization reduces change lifecycle transparency and complicates compliance control with established requirements.

Collectively, the distribution of indicated problems allows viewing them not as disparate shortcomings but as interconnected elements of a single quality management loop, in which digital transformation stability is determined by the ability to purposefully impact precisely the dominant risk zones, rather than individual defect manifestations.

In healthcare conditions, test automation results acquire meaning only when embedded in a formalized validation and change management loop. Here, quality assurance cannot be viewed as an auxiliary engineering function, as any information system changes directly affect clinical, financial, and administrative processes. Therefore, the main question lies not in testing acceleration as such, but in how automation supports inspection reproducibility, requirement traceability, and system lifecycle control in a regulatory environment [6].

Reducing regression inspection time and increasing testing completeness in this context are interpreted as change stability factors. Rapid inspection execution allows preventing the accumulation of non-validated modifications between releases and reduces the risk of desynchronization among documentation, configurations, and actual system behavior. Increasing testing completeness ensures coverage not of individual functions but of holistic business processes, which is fundamentally important for SAP S/4HANA class systems where violations often occur at module and role boundaries. These effects correlate directly with computerized system validation requirements, in which inspection reproducibility and documentability are viewed as basic compliance conditions.

The practical implementation of this approach in the corporate healthcare environment confirms its applied validity. Within one project, an automated quality assurance operational model oriented toward critically significant processes was formed. Scaling automated scenarios allowed substantially reducing regression testing volume and reducing the share of defects identified at late stages. Significantly, automation was used not as a one-time tool but as a sustainable working loop around which the specialized team's activity was organized.

Test automation in the healthcare environment does not substitute regulatory procedures and does not lower computerized system validation requirements. On the contrary, it forms the operational basis for their observance through formalized scenarios, inspection reproducibility, and change controllability. Test procedure repeatability and their linkage to requirements allow viewing automation as an element of the internal quality control system embedded in the SAP S/4HANA lifecycle. In such a loop, quality assurance functions as a mechanism for preventing digital change risks, rather than as a reaction to already identified defects.

CONCLUSION

The conducted study confirms that automated quality assurance during the digital transformation of healthcare organizations based on SAP S/4HANA should be viewed as a mechanism for reducing systemic risks, rather than as an auxiliary tool for accelerating development. Change stability is determined not by the presence of automated tests as such, but by the degree of closure of critical risk zones related to test preparation, maintenance, execution, and result formalization.

The main stability factor is not the presence of automated tests itself, but the degree to which critical quality assurance risk zones are addressed. Controllability is achieved when test preparation, maintenance, execution, and result recording stages are consistently controlled, rather than just individual defects or scenarios.

For the healthcare sector, a fundamental applicability condition is embedding automation into the computerized system validation lifecycle and change management processes. Only with the presence of formalized artifacts, requirement traceability, and reproducible inspections does automation become acceptable in a regulatory environment and suitable for audits and inspections.

Practical implementation experience confirms the feasibility of this approach. A scalable automation model based on SAP and Worksoft in healthcare ensures a significant reduction in regression testing and a decrease in the share of late-stage defects, with stability achieved through team training and organizational development rather than disparate technical solutions.

REFERENCES

1. Barjaktarovic, S., Kovacevic, I., & Pantelic, O. (2025). Exploring the moderating role of personality traits in technology acceptance: A study on SAP S/4 HANA learning among university students. Computers, 14(10), 445. https://doi.org/10.3390/computers14100445
2. Júnior, E., Valejo, A., Valverde-Rebaza, J., & de Oliveira Neves, V. (2025). GenIA-E2ETest: A generative AI-based approach for end-to-end test automation [Preprint]. arXiv. https://doi.org/10.48550/arXiv.2510.01024
3. Kola, V. K. (2025). Enhancing SAP S/4HANA and Salesforce quality assurance & quality control through AI-driven test automation frameworks for regulatory compliance. International Journal of Computer Engineering Science and Emerging Technologies, 11(4). https://doi.org/10.22399/ijcesen.4016
4. Marinescu, Ş. A., Oncioiu, I., & Ghibanu, A.-I. (2025). The digital transformation of healthcare through intelligent technologies: A path dependence-augmented–unified theory of acceptance and use of technology model for clinical decision support systems. Healthcare, 13(11), 1222. https://doi.org/10.3390/healthcare13111222
5. Naqvi, S., & Baqar, M. (2025). Breaking barriers in software testing: The power of AI-driven automation [Preprint]. arXiv. https://doi.org/10.48550/arXiv.2508.16025
6. Raja, J. R., Kella, A., & Narayanasamy, D. (2024). The essential guide to computer system validation in the pharmaceutical industry. Cureus, 16(8), e67555. https://doi.org/10.7759/cureus.67555
7. Ricca, F., Marchetto, A., & Stocco, A. (2025). A multi-year grey literature review on AI-assisted test automation [Preprint]. arXiv. https://doi.org/10.48550/arXiv.2408.06224
8. Sapundzhi, F., Dimitrova, V., Lazarova, M., Georgiev, S., Todorov, M., & Todorov, V. (2025). A cloud-based approach to modeling ERP information flows using a bivariate Pólya–Aeppli process. Mathematics, 13(11), 1699. https://doi.org/10.3390/math13111699

9. Wang, F., Arora, C., Tantithamthavorn, C., Huang, K., & Aleti, A. (2025). Requirements-driven automated software testing: A systematic review [Preprint]. arXiv. https://doi.org/10.48550/arXiv.2502.18694
10. Yao, Y., Wang, J., Hu, Y., Wang, L., Zhou, Y., Chen, J., Gai, X., Wang, Z., & Liu, W. (2024). BugBlitz-AI: An intelligent QA assistant [Preprint]. arXiv. https://doi.org/10.48550/arXiv.2406.04356