TELKOMNIKA Telecommunication Computing Electronics and Control
Vol. 24, No. 2, April 2026, pp. 466~480
ISSN: 1693-6930, DOI: 10.12928/TELKOMNIKA.v24i2.27431

Transforming e-government projects by developing a RAF using Scrum integrated with CASE tool in Botswana

Thapelo Monageng, Bukohwo Michael Esiefarienrhe
Department of Computer Science and Information Systems, North-West University, Mahikeng, South Africa

Article Info

Article history:

Received Jul 25, 2025
Revised Dec 17, 2025
Accepted Jan 30, 2026

Keywords:

Agile methods
Computer-aided software engineering tools
E-government
Risk assessment framework
Scrum

ABSTRACT

The digital transformation in Botswana has placed strong emphasis on e-government initiatives aimed at improving public service delivery. However, these projects continue to face low success rates due to challenges such as inadequate and reactive risk management practices, limited technical expertise, and fragmented implementation. This study proposes an integrated risk assessment framework (RAF) that combines Scrum methodology with computer-aided software engineering (CASE) tools that allows for the development of an automated, proactive, and iterative approach to risk management that is specific to the socioeconomic circumstance of Botswana. A quantitative survey was conducted with 32 project management specialists involved in e-government projects to assess their familiarity with agile methods and CASE tools, perceptions of traditional risk management approaches, and acceptance of the proposed model. The results revealed that 90.6% of respondents were familiar with Scrum, 78.1% had used CASE tools, and 81.25% supported the new framework, highlighting the urgent need for real-time risk tracking and continuous stakeholder engagement. The proposed e-government risk assessment framework (e-GRAF) model offers a flexible and adaptive solution to strengthen risk management processes, increase the success rate of e-government projects, and improve the quality and resilience of digital governance systems in Botswana.

Corresponding Author:

Thapelo Monageng
Department of Computer Science and Information Systems, North-West University
Mmabatho Unit 5, Mahikeng, 2790, South Africa
Email: ndisg@yahoo.com

1. INTRODUCTION

The digital age has ushered in an era of transformation across various sectors, with government's globally increasingly adopting e-government initiatives to enhance service delivery. E-government projects have been initiated with the aim of improving public service delivery. Botswana's adoption of e-government projects aligns with a growing demand for efficient and timely services from governments across Africa. Despite strategic plans and policies aimed at promoting digital governance, the core challenge remains the minimal success rate of these initiatives [1]. However, these projects often encounter obstacles, including inadequate risk management strategies, which impede their success. Traditional risk management approaches in e-government projects often lack real-time monitoring and iterative mitigation, which leads to project failures [2] with researchers now advocating for the integration of advanced technologies like artificial intelligence (AI), blockchain, and continuous auditing to enhance risk mitigation strategies [3]-[5].

This study introduces a novel framework, the e-government risk assessment framework (e-GRAF) model, which goes beyond existing research by fully integrating Scrum methodology with computer-aided software engineering (CASE) tools to create a dynamic, real-time approach to risk management in e-

government projects. Unlike previous studies that have explored Scrum and risk management as separate or loosely connected processes [6]-[8] this framework embeds continuous risk tracking and automated reporting directly into the Scrum workflow. This integration enables proactive identification, assessment, and mitigation of risks throughout the entire project lifecycle. What makes this contribution particularly unique is its contextual adaptation to Botswana's e-government landscape**,** where resource constraints, limited technical capacity, and fragmented implementation structures demand a flexible and responsive model. Supported by empirical data from project management specialists, this study not only proposes a theoretical model but also demonstrates its practical relevance, offering a sustainable pathway to improve the success rate of digital governance initiatives in developing nations.

Botswana like many other African nations prioritises digital transformation which is a national priority, ensuring the success of e-government initiatives which requires a structured approach to risk management and Agile project execution. This framework involves thorough stakeholder analysis, identifying potential risks at each stage of the project lifecycle. By proactively addressing these risks, Botswana can mitigate potential challenges and enhance project outcomes.

For Botswana to successfully implement e-government initiatives, there is needs to establish a stable and interconnected government enterprise architecture (GEA) which is a catalyst for success. GEA will serve as the backbone for integrating various components of the e-government framework, ensuring seamless communication and data exchange between different government entities. In Botswana government's efforts are often driven by individual departments with reliance on central government and external aid [9]. Despite these efforts, challenges such as inadequate infrastructure, limited technical expertise, and resistance to change persist [10].

This research proposes the development of a risk assessment framework (RAF) that integrates Scrum practices and CASE tools to enhance e-government project success in Botswana. The study explores how this integrated approach can enhance risk identification, analysis, mitigation, and monitoring, leading to improved project outcomes.

Although little existing research deals with integrating risk management with Scrum, there is need to understand risk assessment as part of risk management and the potentials of studying risk assessment independently as it is beneficial to its growth, success and importantly the integration of assessing risk with applications. If risks are not managed proactively using a structured approach, then they can result in serious consequences for the project success [11]. Risk assessment in e-government projects is part of the risk management processes which include three crucial stages, identifying, assessing, and mitigating risks throughout the project lifecycle. An iterative risk management process integrated into the Scrum framework can significantly reduce project failures [12]. Scrum is an Agile methodology that relies on short iterations, timely feedback and active collaboration and is known to effectively control risks even though it lacks officially defined project risk management techniques [8]. This proactive approach allows Agile teams to continuously monitor and control risks, ensuring that potential issues are addressed promptly.

Chaouch *et al.* [13] proposed a framework that integrates risk management into Agile development projects by combining Scrum methodology with the project management body of knowledge (PMBOK) guidelines, with a goal is to enhance risk management mechanisms within Scrum to improve project success rates. Tavares *et al.* [14] developed and evaluated a risk management tool for software development projects using Agile methods. The proposed instrument offers a collection of risk management practices in an iterative lifecycle, which aims at improving the efficiency of risk response planning without increasing the time it takes to implement it. Our research differs from this research because we developed a framework that incorporated CASE tools with SCRUM methods for effective risk management. Alzahawi and Abumandil [15] studies show how the Scrum framework is used to execute risk management in information technology (IT) organizations using quantitative methods. The aim of the research determines the influence of the Scrum approach on risk management in IT projects to achieve higher performance and more efficient energy management. Integration of Agile practices into e-government project environments has been explored through tailored frameworks that adapt established methodologies to the unique needs of the public sector [16].

Zahedi *et al.* [17] presented a risk management framework for projects that use the Agile methodology to help the software development process and increase the likelihood of the project's success, with the suggested framework specifying the risk management procedures required for each stage of the Agile methodology, in accordance with the ISO31000 standard. The study by Al-Khouri *et al.* [18] emphasizes the importance of strategic risk assessment and mitigation in large e-government projects, highlighting that such frameworks are crucial for navigating the complexities inherent in these initiatives.

In their study, Conforto *et al.* [19] investigated the applicability of Agile project management (APM) practices beyond the software development sector. They identified critical APM practices including collaborative project planning, shared team responsibility, and frequent project plan updates that enhance adaptability and responsiveness in various industries. This research underscores the potential of Agile methodologies to improve risk adaptability across diverse project environments.

The study titled "a general framework for e-government: definition maturity challenges, opportunities, and success", Almarabeh and AbuAli [2] provided a comprehensive analysis of e-government development. They identify several challenges in implementing e-government initiatives, such as technological infrastructure limitations, resistance to change, and the need for legal and regulatory frameworks. Their study emphasized that the success of e-government projects hinges on strategic planning, stakeholder involvement, and continuous evaluation.

Our study explores how integrating a RAF with Scrum methodology using a CASE tool can enhance the success of e-government projects in Botswana. The RAF provides a systematic approach to identifying, analysing, and mitigating potential risks, while Scrum, an APM methodology, promotes flexibility, iterative development, and continuous stakeholder engagement. By combining these approaches, government agencies can improve project resilience, adaptability, and overall efficiency. Our study examines key risks in Botswana's e-government landscape, the effectiveness of Scrum in addressing these challenges, and how a risk-informed Agile approach can drive better project when combined with a CASE tool. Then we propose the development of a RAF integrated with Scrum methodology and a CASE tool to improve e-government project outcomes. The RAF provides a systematic method for identifying, analysing, and mitigating risks, while Scrum enhances agility, stakeholder collaboration, and iterative development. Additionally, the integration of a CASE tool streamlines software development, automates documentation, and improves system quality. Therefore, this study addresses the following research questions:

- How can a RAF be designed to systematically identify, analyse, and mitigate risks in e-government projects?
- What are the key success factors influencing the successful implementation of a RAF integrated with Scrum and CASE tools in Botswana's e-government projects?
- What role do CASE Tools play in supporting the integration of RAF in e-government projects?

2. MATERIALS AND METHOD

This study used a structured questionnaire to collect data on four central areas: participants' awareness of Scrum methodology, their familiarity with CASE tools, perceptions of traditional risk management practices, and their level of support for the proposed E-GRAF model. The questionnaire consisted of twenty items carefully designed to capture these themes. Each item was rated using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Example statements included, "I am comfortable applying Scrum principles to project management tasks," and "Integrating Scrum with CASE tools will improve the success of e-government projects." A summary of the survey constructs and sample questions is provided in Table 1, while the full questionnaire is available upon request from the corresponding author.

Table 1. Survey instrument summary

Construct	Description	Sample question/Item	Scale
Scrum familiarity	Assesses knowledge and comfort with applying Scrum methodology in project management.	"I am comfortable applying Scrum principles to project management tasks."	1 = strongly disagree to 5 = strongly agree
CASE tool usage	Measures participant experience with CASE tools for documentation and risk tracking.	"I have experience using CASE tools for project documentation and tracking."	1 = strongly disagree to 5 = strongly agree
Perceptions of traditional risk management	Evaluates effectiveness of current risk management practices in participants' organizations.	"Current risk management approaches in my organization are reactive rather than proactive."	1 = strongly disagree to 5 = strongly agree
Support for E-GRAF model	Gauges willingness to adopt and implement the integrated framework in e-government projects.	"Integrating Scrum with CASE tools will improve the success of e-government projects."	1 = strongly disagree to 5 = strongly agree

To ensure clarity and relevance, the questionnaire was piloted with five project management specialists prior to the main data collection. Feedback from this pilot stage led to minor revisions in question wording and flow. The overall reliability of the instrument was assessed using Cronbach's alpha, which produced a value of 0.82, indicating strong internal consistency. Construct validity was tested using exploratory factor analysis (EFA). The Kaiser-Meyer-Olkin (KMO) measure of 0.75 and Bartlett's test of sphericity ($p < 0.001$) confirmed that the data were suitable for factor analysis, with all factor loadings above 0.50, demonstrating that the items effectively captured their intended concepts.

2.1. Agile methodology adaptation

The utilization of Scrum as an Agile methodology, helps manage the dynamic nature of e-government projects. Its iterative approach allows for continuous feedback and adaptation, which is essential to address the changing requirements and risks of e-government projects [20]. This flexibility and adaptability in Scrum ensure that projects remain in tune with the needs of stakeholders and can respond promptly to any unforeseen risks. Using Agile methods.

2.1.1. Utilization of CASE tools

CASE tools facilitate the automation of system development processes, enhancing the efficiency and accuracy of risk assessment. By integrating these tools with Scrum, project teams can streamline their workflows, reduce manual errors, and focus on higher-value tasks [20]. This integration is particularly beneficial in Botswana, where resource constraints can hinder project progress and there is need to chart their utilization pathways.

2.1.2. Research design

This study employed a quantitative research design using a survey method to gather data from project management specialists in Botswana. The primary objective was to assess the need for a structured RAF tailored for e-government projects. The research adopted a descriptive approach to quantify agreement levels regarding the development of a robust framework for e-government projects.

2.1.3. Research population

The research population comprises 32 project management specialists who operate within various sectors in information technology. These specialists are actively involved in managing projects at different levels of complexity and scope. The chosen population is expected to provide a diverse range of insights and experiences relevant to effective project management practices. By focusing on this specific group, the research aims to gain a comprehensive understanding of the methodologies and challenges faced in the field. Furthermore, the selection of professionals with varying backgrounds enriches the data, offering a broader perspective on project management.

2.1.4. Sampling techniques

The study will utilize a purposive sampling technique to select the 32 project management specialists. Purposive sampling is appropriate as it allows for the selection of individuals who possess specific knowledge and experience pertinent to project management. This technique ensures that the sample includes a representative mix of specialists from various government information technology and project management backgrounds. Additionally, participant criteria will be established to identify qualified candidates, such as years of experience, certifications, and roles in project management. Employing this method enhances the likelihood of gathering deep, relevant insights into effective project management strategies.

2.1.5. Sample size

The sample size for this study is set at 32 individuals. This size is chosen to provide a manageable yet diverse dataset that can yield substantive qualitative and quantitative insights while keeping the research feasible within time and resource constraints. A sample of this size allows for in-depth interviews or surveys while ensuring that participants can represent various facets of project management expertise effectively. While generally considered a small sample, a targeted group of specialists can lead to rich, insightful data if selected thoughtfully. The relatively small size also enables detailed analysis of each respondent's contributions.

2.1.6. Validity of research instruments

To ensure the validity of research instruments, a mixed-methods approach will be utilized, combining qualitative and quantitative data collection methods. Surveys or questionnaires will be developed based on established project management frameworks and validated scales to assess participants' competencies and practices effectively. Before full deployment, these instruments will undergo a pilot test with a small subset of project management specialists to identify any ambiguities or misunderstandings in the questions. Additionally, feedback from experts in the field will be garnered to refine the questions further, ensuring they are relevant and accurately measure the intended construct. Validity checks, such as content validity and construct validity, will be conducted to enhance the reliability of the findings.

2.1.7. Ethical considerations

Ethical approval was obtained from the Faculty of Natural and Agricultural Sciences Research Ethics Committee (FNASREC) of the North-West University before the commencement of the study. Approval for data collection was obtained from the Botswana Ministry of Communication and Innovation before the process of data collection commenced. Consent forms were given to the participants who are staff of the various government parastatals aged between 34 years to 50 years old before conducting the survey, ensuring compliance with research ethics. Participants were informed about the purpose of the study, assured of confidentiality, data management plan before and after the study, data retention and disposal policy of the North-West University and provided with the option to withdraw at any stage.

2.2. Data collection

Data collection was conducted through secure online surveys distributed by email. Each invitation included a detailed consent form outlining the study's purpose, confidentiality measures, and data handling procedures. Participants were informed of their right to withdraw at any point without consequence. Ethical clearance was obtained from the FNASREC at North-West University, as well as the Botswana Ministry of Communications and Innovation.

A structured questionnaire was distributed to 32 project management specialists involved in e-government projects within various ministries and IT agencies. Purposive sampling was used to identify participants with significant experience in government technology initiatives. The survey captured participants' perceptions regarding current risk management challenges, the effectiveness of traditional methods, and their anticipated benefits of using an Agile and CASE-integrated RAF. While the sample size is relatively small, it is considered appropriate for exploratory studies that focus on specialized professional groups. The diversity of roles ensured a wide range of perspectives on risk management and Agile practices.
The structured questionnaire designed to collect data consisted of both closed-ended and Likert-scale questions. The questionnaire included items that assessed participants' perceptions of risk assessment in e-government projects, their familiarity with Scrum and CASE tools, the effectiveness of traditional methods, and their anticipated benefits of using an Agile and CASE-integrated RAF.

The data analysis process involved three stages. First, descriptive statistics such as frequencies, percentages, means, and standard deviations were computed to provide an overview of participant responses. Second, Pearson correlation was used to examine relationships between key variables, including Scrum familiarity and support for the E-GRAF model. Before applying this analysis, data were tested for normality using the Shapiro-Wilk test, which confirmed that the assumptions for parametric testing were met. Finally, multiple regression analysis was conducted to determine whether Scrum familiarity and CASE tool usage could predict support for the proposed framework. These inferential analyses provided deeper insights into the factors influencing the adoption of integrated risk management systems.

2.2.1. Key variables assessed

The quantitative results focused on four key variables: awareness of Scrum methodology, experience with CASE tools, perceptions of the effectiveness of traditional risk management practices, and support for the E-GRAF model. These variables represent the foundational elements needed to evaluate the potential of the proposed framework to improve e-government project outcomes in Botswana.

3. RESULTS AND DISCUSSION

The most efficient way to discuss the contribution of this research is to critically examine risk assessment and its various forms and implications of non-compliance by organizations.

3.1. Risk assessment

3.1.1. Risk Identification

Risk identification is the basis for effective risk management. It is a methodical identification of potential risks that could hinder the progress of the e-government project. Risk cannot be completely eliminated from a project, and pursuing risks has a diminishing return. As a result, a risk registry of the most significant hazards should be maintained for management [21]. Proag and Proag [22] describes risk assessment as the action (or inaction) taken to address the risk issues identified and reviewed throughout the assessment and analysis processes, typically with the goal of containing or lowering the risk.

Methods in risk assessment such as strengths, weaknesses, opportunities and threats (SWOT) analysis and brainstorming techniques are essential in the assessment process. Using these techniques, project teams can identify a wide range of risks, from the resistance of stakeholders to technical defects. The use of tools such as risk registers or specialised software improves the identification process further by providing a

systematic way of recording and monitoring risks. This methodological approach lays the basis for further risk assessment and mitigation initiatives, ensuring that all potential vulnerabilities are considered. The identification of potential risks that could affect e-Government projects is the first phase of the establishment of the RAF. It is necessary to hold consultation meetings with the teams and stakeholders to obtain information on the potential risks so that risk identification can be carried out efficiently. A SWOT analysis must also be performed for all e-Government projects. In addition, all risks must be categorised and historical project data must be used to monitor the characteristics of previously identified recurrent risks in government IT projects.

3.1.2. Risk analysis

Once risks are identified, the next step is to analyse their potential impact and likelihood using a risk matrix. This involves evaluating the severity of each risk using a uniform numerical scale, typically ranging very High to very low where very high represents the most severe consequence while very low signify low risk.

3.1.3. Risk prioritization

Risk prioritization is essential for focusing resources on the most critical threats. By categorizing risks into high, medium, and low priorities, project managers can allocate resources effectively and ensure that mitigation efforts are directed towards the most significant risks. Risks should be ranked based on their potential to disrupt project goals and focus should be on high-priority risks that require immediate mitigation strategies. Acceptable risk thresholds must be defined and response plans must be created accordingly.

3.1.4. Risk mitigation and response planning

Effective risk mitigation strategies are crucial for minimizing the impact of identified risks. This involves developing and implementing measures to either reduce the likelihood of risks occurring or lessen their impact if they do materialize. Mitigation strategies should be developed for each identified risk. Implement contingency plans for risks with high impact and preventive strategies (e.g., improving cybersecurity measures, and training personel) must be developed. Each risk must be assigned to a team or individual who will be responsible for it.

3.1.5. Continuous risk monitoring and review

An effective RAF necessitates continuous monitoring and review to adapt to changing circumstances. This process involves regularly updating risk assessments and mitigation strategies to reflect new information and emerging threats. Risk assessment should be embedded as a continuous process in project life cycles and by utilising CASE Tools, risks can be tracked in real time, documents will be automated providing a bridge for predictive analytics. To ensure that framework remains relevant and effective throughout the project lifecycle, continuous monitoring must be done at all cost.

3.2. Critical success factors (CSFs)

CSFs are attributes, quality and values that are responsible for achieving excellence in performance [23]. A successful implementation of the risk assessment framework, integrated with Scrum methodology and CASE tools is required in Botswana e-government initiatives. Several critical factors are necessary for the successful implementation of a RAF integrated with Scrum methodology and CASE tools in Botswana's e-government initiatives. These factors include Government support and engagement, prioritization of functional capability, Agile methodology adaptation and utilization of CASE tools.

3.2.1. Government support and engagement

For e-government initiatives to be successful, leadership dedication and policy alignment are essential [24]. Establishing a clear vision and direction for e-government initiatives requires the involvement of executive management. Senior IT officers in Botswana have determined that executive management must take an active role and lead the implementation of these projects [25]. This participation guarantees that the project gets the required funding and support and is in line with national priorities. By providing adequate funding, establishing unambiguous relations, and encouraging digital transformation, government organisations can give risk assessment and Agile approaches top priority. Top management support is a key factor that cannot be ignored in the successful management of e-government projects [26]. Deeper understanding of the demographic factors influencing opinions of the suggested E-GRAF framework can be gained from the disaggregated results in Table 2.

Table 2. Disaggregated analysis of participant responses by sector and experience level

Demographic group	Familiar with Scrum (%)	Used CASE tools (%)	Supported E-GRAF framework (%)	Mean support score (1–5)
Sector				
Public sector ($n = 14$)	92.9	85.7	85.7	4.6
Semi-public sector ($n = 10$)	90.0	70.0	80.0	4.3
Private sector ($n = 8$)	87.5	62.5	75.0	4.1
Experience level				
Less than 5 years ($n = 7$)	74.1	57.1	57.1	3.9
5–10 years ($n = 13$)	92.3	76.9	84.6	4.4
More than 10 years (n = 12)	100.0	91.7	91.7	4.6

Note: percentages are calculated within each demographic category. Support score derived from five-point Likert scale

Deeper understanding of the demographic factors influencing opinions of the suggested E-GRAF framework can be gained from the disaggregated results in Table 2. Due to their direct involvement in government led digital transformation projects, public sector project management specialists showed the highest levels of support (85.7%) and CASE tool utilization (85.7%). This implies that increased familiarity with Agile approaches and CASE environments is fostered by institutional exposure to e-government systems. Private sector participants, on the other hand, showered lowered lower tool utilization (62.5%) and support rates (75.0%), indicating a lack of interaction with public sector digital governance frameworks. These patterns are further amplified by experience level. The highest mean support score (4.6) and almost universal familiarity with Scrum and CASE Tools were demonstrated by participants with more than ten years of experience. This aligns with prior findings by Bannerman (2008), who emphasized that experienced project managers possess refined risk management intuition and adaptability to Agile systems. Conversely, respondents with less than 5 years of experience expressed weaker support (mean = 3.9), indicating the need for targeted capacity-building and mentorship programs to accelerate Agile literacy.

This analysis reaffirms that sectorial maturity and organizational experience are key determinants of an institution's readiness to adopt Agile methodologies. The strong positive correlation between familiarity with Scrum and support for the E-GRAF model ($r = 0.78$, $p < 0.01$) underscores the importance of Agile competence as a CSF. Although this relationship is evident across all participant groups, it is most prominent among senior professionals. As noted by Conforto *et al*. [19], the use of advanced Agile methods enhances organizational responsiveness and adaptability qualities that are particularly valuable in dynamic environments such as e-government projects. Interpreting these findings through the lens of CSFs reveals three interconnected elements that enable effective implementation of the E-GRAF framework: alignment between sectorial objectives and leadership engagement within the public sector, continuous professional development that strengthens Agile literacy among early-career professionals, and sustained technological investment that supports the adoption of CASE tools. Collectively, these insights extend beyond descriptive analysis, offering a deeper understanding of the mechanisms that foster successful Agile adoption in public systems.

3.2.2. Prioritization of functional capability

Priority of operational capacity is crucial to address the specific needs and challenges of Botswana e-government initiatives. By focussing on core functions, projects can bring tangible benefits to citizens and businesses, such as lowering the costs of doing business with government and ensuring 24 hour service availability [25].

3.2.3. Effective risk assessment and management

A data-driven approach to risk assessment is essential for e-government projects [27]. The RAF should include real-time risk monitoring, predictive analysis and automated risk reporting using CASE tools [28]. Regular risk audits and adaptive risk mitigation strategies ensure the resilience of the project.

Results are displayed in Table 3 below indicating that data collected from the survey were analysed using descriptive statistical methods. The responses were quantified to determine the level of agreement among the specialists regarding the development of a risk assessment framework. The findings revealed that 29 out of 32 respondents (90.6%) were familiar with Scrum, while 3 participants were not familiar with Scrum. At least 25 participants were familiar with CASE tools while 7 claim to never have used them. Of all participants, 22 found traditional methods to be reactive than proactive while 8 prefer to remain neutral with 2 considering traditional approaches to be effective.

Overall, 26 participants or 81.25% were in support of a proposed framework, while 4 or 12.5% were undecided while 2 which constitute to 6.25% disagreed with the proposal.

Table 3. Participant familiarity with Scrum and CASE tools

Variable	Count (n)	Percentage (%)
Awareness of Scrum methodology		
Familiar with Scrum	29	90.6
Not familiar with Scrum	3	9.4
Familiarity with CASE tools		
Used at least one CASE tool	25	78.1
Never used CASE tools	7	21.9

Note: percentages are calculated based on a total sample size of 32 project management specialists

The frequency histogram (Figure 1) illustrates the levels of participant familiarity with Scrum methodology and CASE tools. The results reveal that a large majority of respondents (90.6%) are familiar with Scrum**,** while only a small proportion (9.4%) reported limited or no familiarity. Similarly, 78.1% of participants have used at least one CASE tool in their project management processes, compared to 21.9% who have never used such tools.

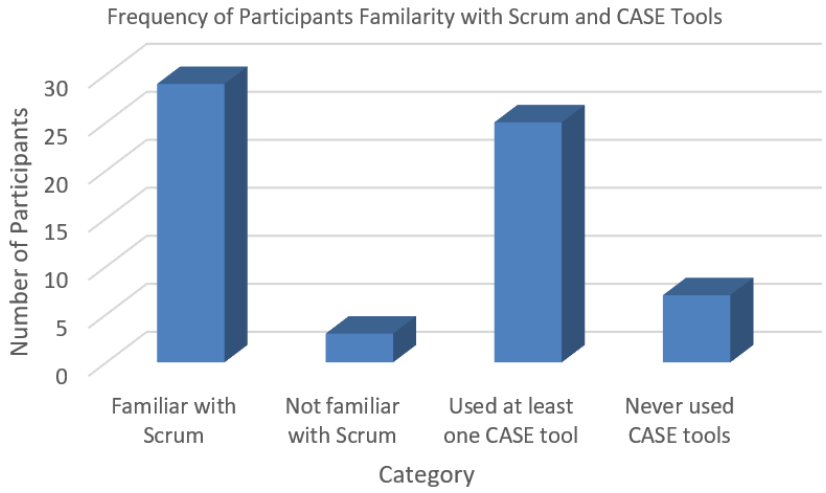

Figure 1. Frequency histogram showing participant familiarity with Scrum methodology and CASE tools

This distribution indicates a strong existing knowledge base of Agile practices and supportive digital tools among project management specialists in Botswana. These findings are important because they suggest that the foundational understanding required for the successful implementation of the proposed e-GRAF model is already present. The relatively high awareness of Scrum provides a fertile ground for introducing a framework that integrates iterative risk management with automated CASE functionalities. Conversely, the smaller group with low CASE tool exposure highlights the need for targeted training and capacity-building initiatives before large-scale rollout.

The Table 4 summarizes participants' perceptions of traditional risk management practices and their views on the proposed E-GRAF framework. A majority of respondents (68.75%) felt that traditional risk management approaches are reactive rather than proactive, while only 6.25% considered them effective, highlighting a widespread recognition of current gaps in managing project risks.

Table 4. Results table

Variables	Count (n)	Percentage %
Perception of traditional risk management		
Found traditional risk management reactive rather than proactive	22	68.75
Neutral	8	25
Considered traditional approaches effective	2	6.25
Agreement on proposed framework		
In support of the idea	26	81.25
Undecided	4	12.5
Disagreed-prefer traditional methods	2	6.25
Risk identification and mitigation efficiency ratings scale of 1 (very poor) to 5 (excellent)		

When presented with the E-GRAF framework, most participants (81.25%) expressed strong support for its adoption, with only two participants (6.25%) preferring to continue with traditional methods. A small group (12.5%) remained undecided, suggesting that additional awareness and training may be required to fully secure stakeholder buy-in.

These findings demonstrate a clear demand for more Agile, forward-looking risk management strategies. The strong endorsement of the proposed framework indicates that participants believe integrating Scrum practices with CASE tool support could significantly enhance risk identification and mitigation efficiency, which were rated on a scale from 1 (very poor) to 5 (excellent).

While the overwhelming majority of participants expressed support for the E-GRAF model, two respondents voiced reservations. Qualitative comments from these individuals revealed concerns about implementation costs and the steep learning curve associated with CASE tools**.** One participant noted that "many government departments lack the technical expertise and resources needed to adopt such a comprehensive framework." These dissenting views are important because they highlight practical barriers that must be addressed during rollout. Resistance rooted in financial and training challenges suggests that successful implementation will require phased adoption, supported by adequate funding and targeted capacity-building initiatives. Exploring these concerns in greater depth through follow-up interviews could provide valuable insights for policymakers and project leaders.

Further Table 5 risk management efficiency ratings present the mean scores and standard deviations for the three key dimensions of risk management assessed in the study. Risk identification received the highest mean score (4.3, standard deviation (SD) = 0.64), indicating strong agreement among participants on the importance of systematically identifying potential risks early in e-government projects. Risk mitigation followed closely with a mean of 4.1 (SD = 0.72), reflecting broad support for proactive measures to address identified risks. Monitoring and control scored slightly lower (mean = 4.0, SD = 0.79), suggesting that while participants value ongoing oversight, there may be gaps in current practices that limit its effectiveness. Overall, these results demonstrate a clear recognition of the need for comprehensive and continuous risk management throughout the project lifecycle.

Table 5. Risk management efficiency ratings

Formulas	Dimension	Mean	SD
$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$	Risk identification	4.3	0.64
	Risk mitigation	4.1	0.72
$Mean = \frac{\sum x_i}{n}$	Monitoring and control	4.0	0.79

To explore the relationship between Scrum familiarity and support for the proposed E-GRAF model, a correlation analysis was conducted. As illustrated in Figure 2, there is a strong positive correlation ($r = 0.78$, $p < 0.01$) between these variables. The scatter plot demonstrates that participants with higher familiarity with Scrum are significantly more likely to express strong support for the integrated risk assessment framework. The upward trend of the regression line confirms this direct relationship.

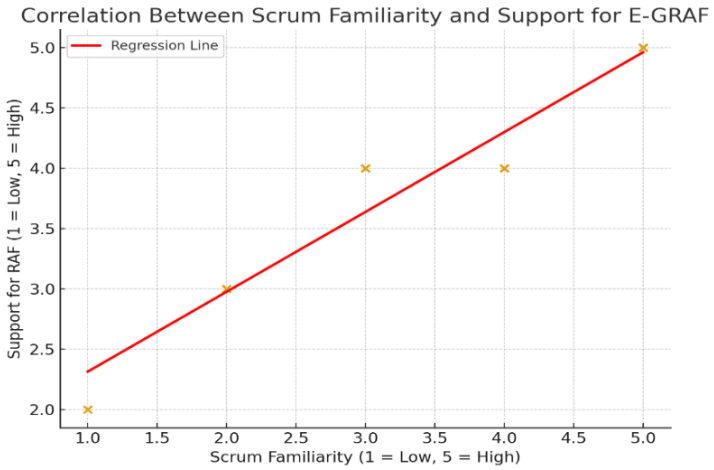

Figure 2. Correlation analysis of Scrum familiarity and E-GRAF support

This correlation suggests that Agile literacy is a critical enabler for adopting advanced risk management frameworks**.** Practically, this means that individuals who understand Scrum principles are better positioned to appreciate the iterative and collaborative nature of E-GRAF, which combines Scrum with CASE tool automation for continuous risk tracking. The implication for policymakers and project leaders is clear**:** training programs focused on Scrum and Agile practices should be prioritized**,** as increasing familiarity will directly enhance stakeholder buy-in and overall framework adoption.

The visual analyssis complement the statistical data by providing a clearer understanding of participant readiness and acceptance. The frequency histogram highlights the strong baseline knowledge of Scrum and CASE tools, while the scatter plot emphasizes the strategic importance of Agile training in driving successful implementation of E-GRAF. Together, these insights reinforce the potential of the proposed framework to transform Botswana's e-government projects by aligning technological capability with human expertise.

Pearson correlation analysis is used to measure the strength and direction of the linear relationship between two continuous variables by measuring the strength of linear association between two variables [29], [30]. It helps validate hypotheses by quantifying how changes in one variable relate to changes in another. A Pearson correlation analysis showed a strong positive correlation ($r = 0.78$, $p < 0.01$) between familiarity with Scrum and agreement with the new RAF model. Similarly, there was a moderate correlation ($r = 0.61$, $p < 0.05$) between experience with CASE tools and confidence in the model's ability to automate risk tracking.

In summary and based on the results, professionals who are familiar with Agile methodologies and Case tools appear to strongly support the suggested RAF developed with Scrum and integrated CASE Tool. Most people acknowledge that the traditional risk management techniques are ineffective and are receptive to more flexible, iterative approaches.

The survey findings align closely with several CSFs for e-government projects identified in prior studies. High levels of Scrum familiarity (mean = 4.5) and strong support for E-GRAF (81%) point to the importance of Agile literacy as a success factor. Similarly, the moderate use of CASE tools (mean = 4.0) underscores technological readiness as another CSF, while concerns about training and resource availability raised by some participants highlight the role of capacity-building and stakeholder engagement**.** Quantitatively linking these perceptions to CSFs provides empirical evidence that organizational readiness, Agile training, and technology infrastructure are not abstract success factors but concrete enablers for digital transformation in Botswana's e-government ecosystem.

While this study focused on Botswana, many of the challenges it addresses such as limited resources, digital skill gaps, and fragmented risk management practices are common across developing countries. The E-GRAF framework could be adapted in stable developing countries with modifications to reflect each country's governance structures, technology infrastructure, and policy priorities. For example, countries with higher digital maturity might adopt more automated CASE tool functions, whereas resource-constrained environments could begin with simplified, low-cost versions of the framework. This adaptability makes E-GRAF relevant beyond Botswana while maintaining sensitivity to local settings.

4. PROPOSED MODEL

The proposed framework, referred to as E-GRAF, integrates Scrum methodology with CASE tools to establish a dynamic and iterative approach to risk management in e-government projects. The model addresses the persistent challenges faced by Botswana's digital governance initiatives, such as fragmented implementation, reactive risk management, and limited technical capacity. By embedding risk management activities into the Scrum workflow and leveraging CASE tools for automation, E-GRAF ensures that risks are continuously identified, assessed, and mitigated throughout the project lifecycle.

Figure 3 provides a visual representation of the E-GRAF model, illustrating the flow of activities, roles, and artifacts. Figure 3. The E-GRAF model integrating Scrum, risk assessment, and CASE tools for e-government projects. The framework highlights iterative sprints, continuous monitoring, and role interactions between project managers, sprint teams, and stakeholders.

As shown in Figure 3, the process begins with risk identification, led primarily by the project manager (blue icon), who collaborates with stakeholders (yellow icon) to gather information on potential threats. These identified risks are documented and prioritized to form the foundation for sprint planning, where the sprint team (green icon) develops an action plan for addressing the most pressing issues.

Once planning is complete, the team enters iterative sprint cycles, during which risk assessment and mitigation activities are embedded into Scrum practices such as daily stand-ups, backlog refinement, and sprint reviews. Each sprint acts as a continuous improvement cycle, with new and evolving risks being recorded and managed in real time. This iterative loop ensures that risk management is not a one-time task but an ongoing, adaptive process.

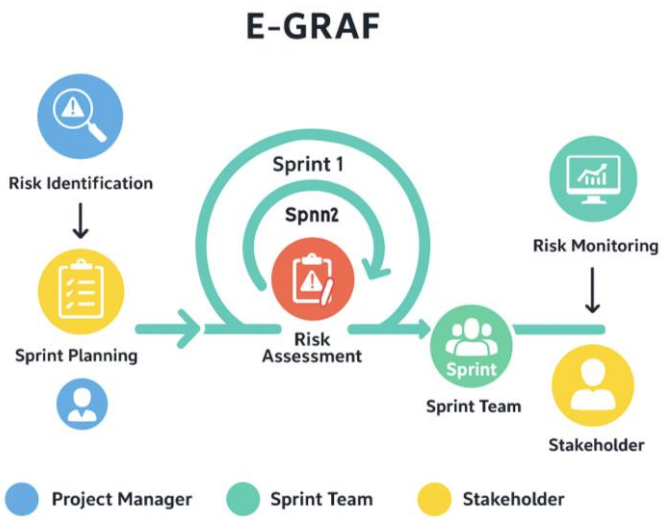

Figure 3. Proposed E-GRAF model

The CASE tool plays a crucial supporting role throughout the framework. It automates key processes such as real-time documentation, risk tracking, and predictive analytics, enabling teams to focus on strategic decision-making rather than repetitive administrative tasks. By integrating CASE tools, E-GRAF allows for timely reporting and efficient data sharing between government departments, ultimately improving transparency and accountability.

At the final stage, continuous monitoring and review are conducted to evaluate the effectiveness of mitigation strategies and to refine future sprints. This step fosters a proactive culture of learning, ensuring that lessons from completed sprints feed directly into the planning of subsequent iterations. Stakeholders are actively involved in this stage, providing feedback to validate outcomes and align the project with national digital transformation goals.

The strength of the E-GRAF model lies in its clear role definition and structured workflow, which ensure accountability and smooth coordination throughout the project lifecycle. The Project Manager plays a central role by overseeing overall strategy, managing resources, and making high-level decisions that guide the direction of the project. The Sprint Team is responsible for executing development tasks and carrying out the mitigation strategies designed to address identified risks within each sprint cycle. Meanwhile, Stakeholders remain actively involved by providing continuous feedback and validating outcomes to ensure that the project remains aligned with citizen needs, service delivery expectations, and broader policy objectives. This well-defined division of roles fosters collaboration, transparency, and responsiveness, which are essential for the successful implementation of e-government initiatives.

By combining Scrum's iterative adaptability with the automation power of CASE tools, E-GRAF enables e-government projects to move beyond reactive, fragmented risk management approaches. Instead, it promotes real-time, data-driven decision-making, improving project resilience, stakeholder engagement, and ultimately, the success rate of Botswana's digital governance initiatives.

Integrating risk assessment into Scrum will foster a proactive mindset that values discovery, assessment and mitigation of risks throughout the project lifecycle. The iterative nature of Agile is aligned with the automated capabilities of CASE tools, which teams can use to continuously monitor and address risks. Because of the integration, risk management tasks are incorporated into each sprint, enabling continuous assessment and modification of risk mitigation techniques.

CASE tools support the automation of software development processes and can help manage risk in Scrum projects. CASE tools automate repetitive tasks, allowing Scrum teams to focus on critical risk management activities and they provide real time information on project risks, allowing teams to react quickly to emerging risks. This opens better communication and cooperation between team members, ensuring that all are aligned in risk-management strategies.

The proposed RAF integration (Figure 4) includes the following key elements:

– Risk identification: by using techniques such as brainstorming and information gathering, teams can create a comprehensive list of risks. Risks are assessed daily through stand-up meetings. New risks are logged, and mitigation strategies are updated in real time. These risks are documented, together with a description of their potential impact and initial considerations for risk management.

- Risk assessment methods: once identified, risks are categorized based on their impact and likelihood. This structured assessment enables teams to prioritize risks effectively and devise appropriate mitigation strategies [13]. This involves qualitative and quantitative analysis to prioritize risks based on their potential effect on project objectives. These methods help to assess the likelihood of each identified risk and its potential impact on the project.
- Risk response and monitoring: the framework proposes tools for risk response such as risk assessments, risk checklists and simulation tools for scenarios. Monitoring and risk control are essential to ensure that the risk management process remains effective throughout the project lifecycle in real time. Monitoring and controlling risk in agile projects include having a steering committee that oversees the entire project, creating a culture that adopts agile projects, and training employees on the hybrid [31].
- Integration with CASE tools: CASE tools support the automation of software development processes and can help manage risk in Scrum projects. These tools can be used to document risk management processes, simulate scenarios and provide real-time risk status updates.

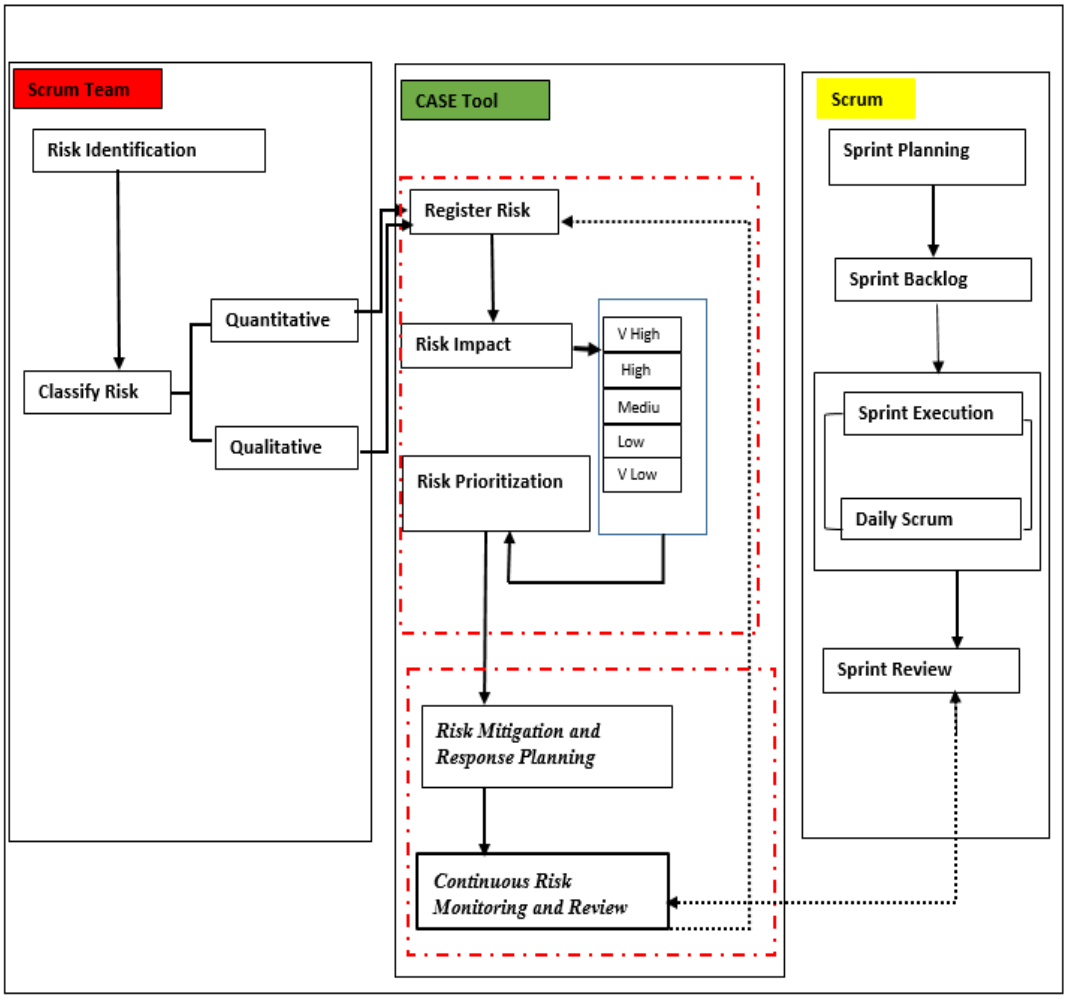

Figure 4. Proposed RAF integration

5. CONCLUSION

The transformation of e-government projects in Botswana through the integration of risk assessment frameworks and Scrum methodology holds significant promise for improving public service delivery. While this study provides valuable insights into agile risk management and its potential to improve e-government project outcomes, several limitations must be acknowledged. The sample size of 32 participants is relatively small and drawn from a purposive sampling approach. Although this was appropriate for an exploratory study focused on a specialized group of project management professionals, it limits the generalizability of the findings to all e-government stakeholders in Botswana or other countries. Another factor that raises the

possibility of report bias is that the data were self-reported, which introduces the possibility of response bias. Participants may have overestimated their familiarity with Scrum or their readiness to adopt CASE tools. Additionally, the study did not include direct observational or performance-based measures of agile practices, which could have provided a more objective assessment of organizational readiness. The lack of a qualitative component also meant that some nuances, like the causes of opposition to e-GRAF adoption, could not be thoroughly examined, even though the study collected rich qualitative data.

Future research should build on these findings by using mixed-methods approaches that combine larger-scale surveys with qualitative interviews or focus groups to gain both statistical insights and deeper understanding of the motivations and challenges influencing agile risk management adoption. Longitudinal studies are also needed to track the real-world application of the E-GRAF framework across multiple project cycles, allowing researchers to assess its effectiveness over time and refine it based on practical lessons. Comparative studies across different developing countries could help determine which aspects of the framework are broadly applicable and which require local adaptation. In addition, the integration of emerging technologies such as artificial intelligence and machine learning could be explored to enhance automation, particularly in risk prediction and early-warning systems. By pursuing these directions, future research can generate actionable strategies that support policymakers, project managers, and technology teams in strengthening digital governance in Botswana and similar settings.

FUNDING INFORMATION

The authors state that there was no funding for this research.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Thapelo Monageng	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Bukohwo Michael Esiefarienrhe	✓			✓	✓	✓	✓			✓	✓	✓	✓	✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors state there is no conflict of interest.

INFORMED CONSENT

The authors obtained informed consent from participantsa in this study.

ETHICAL APPROVAL

The study was approved by the Faculty of Natural and Agriculture Sciences Ethics Committee (FNASREC) of the North-West University, South Africa as a low-risk study with ethics number NWU-01288-24-A9.

DATA AVAILABILITY

The data that support the findings of this study are available on request from the corresponding author, [T, Monageng]. The data, which contain information that could compromise the privacy of research participants, is not publicly available due to ethical consideration.

REFERENCES

[1] R. Heeks, "Benchmarking e-Government: Improving the national and international measurement, evaluation and comparison of e-Government," in *Evaluating Information Systems: Public and Private Sector*, Elsevier, 2008, pp. 257–301, doi: 10.1016/b978-0-7506-8587-0.50017-2.

[2] T. Almarabeh and A. AbuAli, "A general framework for E-government: Definition maturity challenges, opportunities, and success," *European Journal of Scientific Research*, vol. 39, no. 1, pp. 29–42, 2010.

[3] M. El Khatib, L. Nakand, S. Almarzooqi, and A. Almarzooqi, "E-Governance in Project Management: Impact and Risks of Implementation," *American Journal of Industrial and Business Management*, vol. 10, no. 12, pp. 1785–1811, 2020, doi: 10.4236/ajibm.2020.1012111.

[4] E. Vyhmeister and G. G. Castane, "TAI-PRM: trustworthy AI—project risk management framework towards Industry 5.0," *AI and Ethics*, vol. 5, no. 2, pp. 819–839, Apr. 2025, doi: 10.1007/s43681-023-00417-y.

[5] K. Tian, Z. Zhu, J. Mbachu, A. Ghanbaripour, and M. Moorhead, "Artificial intelligence in risk management within the realm of construction projects: A bibliometric analysis and systematic literature review," *Journal of Innovation and Knowledge*, vol. 10, no. 3, p. 100711, May 2025, doi: 10.1016/j.jik.2025.100711.

[6] P.-Marańda and J. Kuna, "Risk Management in IT Project in the Framework of Agile Development," in *Proceedings of the 18th International Conference on Software Technologies*, Rome, Italy: SCITEPRESS - Science and Technology Publications, 2023, pp. 540–547, doi: 10.5220/0012127800003538.

[7] F. V. Garcia, J. C. R. Hauck, and F. N. Rizzo Hahn, "Managing Risks in Agile Methods: a Systematic Literature Mapping," in *Proceedings of the International Conference on Software Engineering and Knowledge Engineering, SEKE*, Jul. 2022, pp. 394–399, doi: 10.18293/SEKE2022-123.

[8] L. Bisikirskienė, L. Čeponienė, G. Vilutis, and A. Nečionytė, "Software Project Risk Identification Based on Scrum Artifacts," *Applied Sciences (Switzerland)*, vol. 15, no. 2, p. 824, Jan. 2025, doi: 10.3390/app15020824.

[9] T. A. Samboma, "e-Government, A tool for service delivery in Botswana's local authorities?," *Global Journal of Human Social Science*, vol. 19, no. 1, pp. 1–4, 2019.

[10] N. Nkwe, "E-government: challenges and opportunities in Botswana," *International Journal of Humanities and Social Science*, vol. 2, no. 17, pp. 39–48, Sep. 2012.

[11] J. Song, M. Munyinda, and P. Adu Sarfo, "Examining the impact of risk management practices on sustainable project performance in the construction industry: the role of stakeholder engagement," *Frontiers in Built Environment*, vol. 11, p. 1575827, May 2025, doi: 10.3389/fbuil.2025.1575827.

[12] M. Hammad and I. Inayat, "Integrating risk management in scrum framework," in *Proceedings - 2018 International Conference on Frontiers of Information Technology, FIT 2018*, Islamabad, Pakistan: IEEE, Dec. 2018, pp. 158–163, doi: 10.1109/FIT.2018.00035.

[13] S. Chaouch, A. Mejri, and S. A. Ghannouchi, "A framework for risk management in Scrum development process," *Procedia Computer Science*, vol. 164, pp. 187–192, 2019, doi: 10.1016/j.procs.2019.12.171.

[14] B. G. Tavares, M. Keil, C. E. Sanches da Silva, and A. D. de Souza, "A Risk Management Tool for Agile Software Development," *Journal of Computer Information Systems*, vol. 61, no. 6, pp. 561–570, Nov. 2021, doi: 10.1080/08874417.2020.1839813.

[15] A. M. Y. Alzahawi and M. Abumandil, "Evaluating the role of scrum methodology for risk management in information technology enterprises," *Journal of Information Technology and Computing*, vol. 2, no. 1, pp. 1–8, Jul. 2021, doi: 10.48185/jitc.v2i1.159.

[16] P. Ciancarini, R. Giancarlo, and G. Grimaudo, "Scrum@PA: Tailoring an Agile Methodology to the Digital Transformation in the Public Sector," *Information (Switzerland)*, vol. 15, no. 2, p. 110, Feb. 2024, doi: 10.3390/info15020110.

[17] M. H. Zahedi, A. R. Kashanaki, and E. Farahani, "Risk management framework in Agile software development methodology," *International Journal of Electrical and Computer Engineering*, vol. 13, no. 4, pp. 4379–4387, Aug. 2023, doi: 10.11591/ijece.v13i4.pp4379-4387.

[18] N. M. Al-Khouri, A.M. and Al-Mazrouei, "A Strategy Framework for the Risk Assessment and Mitigation for Large e-Government Projects," *International Journal of Computer Science and Network Security*, vol. 10, no. 10, pp. 29–34, 2010.

[19] E. C. Conforto, F. Salum, D. C. Amaral, S. L. Da Silva, and L. F. M. De Almeida, "Can agile project management be adopted by industries other than software development?," *Project Management Journal*, vol. 45, no. 3, pp. 21–34, Jun. 2014, doi: 10.1002/pmj.21410.

[20] T. Monageng, "Automating System Risk Identification for E-Government Project Management System using Agile Case Tool Scrum," *Global Scientific Journal*, vol. 13, no. 2, 2025.

[21] E. S. Chia, "Risk assessment framework for project management," in *IEEE International Engineering Management Conference*, Salvador, Bahia, Brazil: IEEE, Sep. 2006, pp. 376–379, doi: 10.1109/IEMC.2006.4279889.

[22] S.-L. Proag and V. Proag, "A Framework for Risk Assessment," *Procedia Economics and Finance*, vol. 18, pp. 206–213, 2014, doi: 10.1016/s2212-5671(14)00932-0.

[23] B. M. Esiefarienrhe and T. Monageng, "Critical success factors frameworks, and models for risk assessment of eGovernment projects: A systematic literature review," *Journal of Infrastructure, Policy and Development*, vol. 8, no. 8, p. 4503, Aug. 2024, doi: 10.24294/jipd.v8i8.4503.

[24] R. Heeks, "Most eGovernment-for-Development Projects Fail: How Can Risks be Reduced?," *SSRN Electronic Journal*, 2020, doi: 10.2139/ssrn.3540052.

[25] C. B. Mokone, O. T. Eyitayo, and A. Masizana- Katongo, "Critical Success Factors for e-Government Projects: The case of Botswana," *Journal of e-Government Studies and Best Practices*, vol. 2018, pp. 1–14, Oct. 2018, doi: 10.5171/2018.335906.

[26] S. K. Aikins, Ed., *Managing E-Government Projects: Concepts, Issues, and Best Practices*. IGI Global, 2012.

[27] P. L. Bannerman, "Risk and risk management in software projects: A reassessment," *Journal of Systems and Software*, vol. 81, no. 12, pp. 2118–2133, Dec. 2008, doi: 10.1016/j.jss.2008.03.059.

[28] N. Agarwal and U. Rathod, "Defining 'success' for software projects: An exploratory revelation," *International Journal of Project Management*, vol. 24, no. 4, pp. 358–370, May 2006, doi: 10.1016/j.ijproman.2005.11.009.

[29] P. Schober and L. A. Schwarte, "Correlation coefficients: Appropriate use and interpretation," *Anesthesia and Analgesia*, vol. 126, no. 5, pp. 1763–1768, May 2018, doi: 10.1213/ANE.0000000000002864.

[30] P. Sedgwick, "Pearson's correlation coefficient," *BMJ*, vol. 345, no. jul04 1, pp. e4483–e4483, Jul. 2012, doi: 10.1136/bmj.e4483.

[31] M. Elkhatib, A. Al Hosani, I. Al Hosani, and K. Albuflasa, "Agile Project Management and Project Risks Improvements: Pros and Cons," *Modern Economy*, vol. 13, no. 09, pp. 1157–1176, 2022, doi: 10.4236/me.2022.139061.

BIOGRAPHIES OF AUTHORS

Thapelo Monageng received B.A (Hons) degree in Computer Studies from the University of Sunderland, in 2008, and the Master's degree in Computer Systems Security from University of South Wales, Wales, and United Kingdom in 2010 and is currently persuing his Ph.D. degree in Information Systems with Computer Science at North-west University in Mahikeng, South Africa respectively. His current research interests include e-government risk assessment model and framework development in developing countries, Gen-z adoption of information technology adoptions and MIoT for Future developments. He can be contacted at email: ndisg@yahoo.com.

Bukohwo Michael Esiefarienrhe received the Ph.D. degree in Computer Science with specialization in Software Engineering from Northwest University, South Africa. He is a Professor of Computer Science in the Computer Science and IS, Northwest, Mahikeng, South Africa. He is involved in research and development, masters and doctoral supervision. Teaching of computer science and information systems courses in both undergrad and postgraduate students and training of corporate personnel. Software development. networking (LAN, WAN, PAN, MAN, wireless, MANET, IoT, WSN) and databases transactions and concurrency. He can be contacted at email: Michael.Esiefarienrhe@nwu.ac.za.