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Conceptual Framework for Auditing Agile Projects

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ABSTRACT Most organizations use IT projects as vehicles to implement the IT strategy which contributes to achieving organizational strategic objectives and goals. Agile project management has been a potential solution to deliver successful IT projects instead of the traditional waterfall approach. This potential has resulted in organizations adopting agile project management to deliver IT projects on time and realise benefits. However, auditors especially those whose experience lies with more traditional and system development life cycle controls are struggling with how to audit agile projects. The problem addressed in this article is lack of an audit framework for auditing agile projects to ensure IT project success. The purpose of this article is to present the proposed conceptual framework for auditing agile projects that are implemented using Scrum methodology. The framework introduces audit processes in each process of the Scrum methodology. The quantitative research method used online survey questionnaire to validate the conceptual framework amongst IT professionals in South Africa. The data were analyzed using SPSS 26.0. The research revealed that there was a significant correlation between the identified audit processes and agile project success. This research emphasizes on the need to take into account auditing agile project from its initiation to closure. This article contributes to the body of knowledge with regard to project auditing. Auditors can use the proposed framework to audit agile projects which are implemented using Scrum methodology to ensure successful completion of IT projects.

INDEX TERMS Agile project, agile methods, project audit, project success, software quality assurance, information technology.

I. INTRODUCTION

Information technology (IT) projects are vehicles that organizations use to implement the IT strategy, which contributes to achieving organizational strategic objectives and goals. In monetary value, from 2014 to 2020, US\$24 751 billion was spent on IT projects worldwide; of this US\$17 820 billion was wasted on failed IT projects [30]. In the period 2015 to 2020, South Africa spent R417.2 billion on IT projects, R221.1 billion of which was wasted on failed IT projects [30]. These statistics indicate that IT projects are still failing and not delivering the strategic organizational goals and objectives. Agile project management has been a potential solution to deliver successful IT projects instead of the traditional waterfall approach [4], [7], [30]. 71% of organizations worldwide are adopting agile project management to improve the success rates of IT projects [40]. The adoption of agile project

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management has resulted in organizations increasing their productivity, improving efficiency and delivering projects on time [50], [51].

However, auditors, especially those whose experience lies with more traditional and system development life cycle controls, are struggling with how to audit agile projects [49]. Project auditing throughout the project life cycle helps to identify project risks earlier, trigger timely corrective actions and improve project performance, which increases the chances of delivering a successful project [32]. There are limited research studies on how to audit agile projects, meaning that auditing agile projects is still a new area in research. Literature reveals that there is a lack of an audit framework for auditing agile projects [14], [41], [49].

In this study a conceptual framework for auditing agile projects was developed and validated among 77 IT professionals in South Africa. The main objective of this article is to present the proposed conceptual framework for auditing agile projects. The framework has audit processes which can

be used by auditors to audit agile projects to ensure the successful delivery of these projects.

The article is organized as follows: Section 2 provides a literature review on the agile concept, agile methods, software quality assurance and agile project auditing. Section 3 presents a discussion of a conceptual framework for auditing agile projects. The research methodology is dealt with in Section 4. Results are discussed in Section 5 and the findings are presented in Section 6. Finally, conclusions and recommendations for future research are made in Section 7.

II. LITERATURE REVIEW

A. DEVELOPMENT, VALIDATION AND VERIFICATION

The term ‘development’ has various meanings to different people and can be explained in different contexts. Development is defined as “transformation from current states to desired one” [39]. Reference [54] defined validation as “a global term encompassing both verification and evaluation”. Verification is about examining the system against its specifications [54]. Validation is concern with examining either a particular design meets its intended purpose [54]. In this study, validation means verifying and evaluating the conceptual framework to meet a research objective. Development means a process of creating something new that adds value and solve a certain problem.

B. CONCEPTUALIZATION OF INFORMATION TECHNOLOGY PROJECTS

Information Technology projects are organizational investments that require money, time, people, technology, facilities, equipment, and processes [42]. Information technology (IT) projects are implemented in organizations to provide benefits such as to create strategic business value in return for IT investment, to achieve greater efficiency and to improve service delivery to customers [32].

However, there are some of the challenges facing IT projects include unclear requirements, requirements gap in the final product, project scope creep, poor communication between project team members, project infrastructure delivery delay, undefined project dependencies, poor stakeholders management, inadequate support from the top management, lack of project management methodology, lack of project audit processes throughout the project life cycle, project go-live failure, lack of post-project support and maintenance plan, lack of project management best practices, poor risk assessment and management, cost overruns, IT project managers do not assign Key Performance Indicators (KPIs) to project benefits [32], [40].

IT projects differ from other projects because they involve using hardware, software, and networks to create a final product, service or result [42].

C. AGILE CONCEPT

The agile concept was introduced by a group of developers in 2001. Agile project management is an approach that is

used to design and deliver software that has the greatest value to the customer [9]. There are various definitions of agile project management. According to Wideman [52], agile project management is “a conceptual project management framework for undertaking software development projects in which the emphasis is moved from planning to execution”. Lemétayer and Sheffield [28] define agile project management as “an iterative lifecycle designed based on short delivery cycles to deal with uncertainty in scope and rapid change in requirements”. Furthermore, they [28] argue that agile project management is value driven rather than plan driven. Agile project management is guided by the Agile Manifesto, which consists of four values and twelve principles to improve software development processes [5]. The four values are: (i) Individuals and interactions over processes and tools; (ii) Working software over comprehensive documentation; (iii) Customer collaboration over contract negotiation; and (iv) Responding to change over following a plan. The Agile Manifesto is the baseline for researchers and practitioners to introduce a variety of agile methods that all comply with the spirit of agile.

D. AGILE METHODS

The philosophy of the agile method is designed around a set of core concepts, including agile practices, measurement metrics and decision making [24]. The core characteristics of agile are self-organizing teams, fast execution, value driven and business oriented. Agile practice is basically promoting the concept of self-organizing (self-directed) teams that are empowered to organize their work on their own [8], [22]. Each of the agile methods shares the values described in the Agile Manifesto.

Agile encompasses various methods, including Adaptive Software Development (ASD), Agile Unified Process (AUP), Crystal Methods, Dynamic System Development Methodology (DSDM), eXtreme Programming (XP), Feature Driven Development (FDD), Lean Software Development (LSD), Kanban, Scrum and Scrum ban [7], [8], [22]. Cao *et al.* [8] explain that all the agile methods share the same practice and have a common approach, but each method has its unique strategy and characteristics.

The survey by PMI Pulse of the Profession [40], [51] reveals that Scrum is the most widely used agile method, as shown in table 1. Therefore, this study focused on Scrum to develop a framework for auditing agile projects.

TABLE 1. Agile methods most used in organizations.

Agile method	PMI Pulse of the Profession (2017)	VersionOne (2018)
Lean	67%	2%
Scrum	55%	54%
XP	42%	1%

E. SCRUM OVERVIEW

Scrum is a project management framework that is applicable to any type of project in any industry including IT [9]. In Scrum, projects are managed with small teams in a series of iterations called sprints. The primary focus is on delivering products that satisfy customer requirements in small iterative shippable increments. There are three core roles in scrum that ensure the project objectives are met. The core roles are the product owner, scrum master and scrum team. On scrum, the roles of the project manager are distributed which entails that project management functions are shared between scrum team, scrum master and product owner. The emphasis in scrum is on self-organization and self-motivation where the team assumes greater responsibility in making a project successful. According to [9] and [21] Scrum framework comprises of the following processes:

- **Product Vision:** The statement describing the vision for the product which is aligned with the organization's business needs.
- **Release Planning:** The purpose of a release planning is to establish the schedule for the product releases. The meeting is conducted to determine the length of the iterations and sprint meetings. This includes release plans for multiple sprints.
- **Product Backlog:** The list of the product requirements (user stories) are included in the product backlog. The user stories are selected for development based on the priority levels assigned by the customer. Items listed in the product backlog support the delivery of the product vision.
- **Sprint Backlog:** Sprint backlog includes the list of requirements selected from the product backlog that are included in a particular sprint. Sprint backlog has sprint (iteration) which comprises of sprint planning meeting, daily scrum meeting, sprint review meeting and sprint retrospectives. The duration of sprint iteration is two weeks to one month which are used to build a potentially shippable product increment to a customer.
- **Shippable Product (Product Deliverable):** At the end of each sprint, the product deliverable that met acceptance criteria is shipped to the customer.

F. SOFTWARE QUALITY ASSURANCE ON AGILE PROJECTS

Software quality assurance (SQA) is defined as “a planned and systematic approach to the evaluation of the quality of and adherence to software product standards, processes, and procedures” [17]. SQA is vital during all the phases of the software development process to achieve the required and higher level of quality in terms of product and process. The software product quality attributes, such as functional suitability, performance, efficiency, compatibility, usability, reliability, security, maintainability and portability [37], are analyzed to achieve SQA [43]. SQA is the key to successful IT projects.

Agile methods rely on agile values and guiding principles to deliver high-quality software [5]. This claim has increased the usage of agile in the software and IT industries [4], [7], [31]. Agile methods for software development have been adopted by many organizations to improve the quality of software products. The quality in agile projects influences project success [1], [2]. SQA in agile involves quality in the software development process and quality of the product [47]. The quality assurance activities in software development are the backbone of the project. The SQA practices are different in each agile method [29], [48].

In scrum methodology, the most commonly used SQA practices are code reviews, test driven development (TDD) and close collaboration [17], [31], [43], [49]. Code reviews help to improve quality and knowledge sharing among scrum project developers. Test driven development Close collaboration is the process where customers and the scrum development team meet together on a daily basis to gain understanding on what is being developed by the developers. This practice of SQA ensures that requirements are correctly understood by stakeholders and that the final product meets the customer business needs.

G. AGILE PROJECT SUCCESS

Project success has different perceptions since its evolution to present [32]. Project success includes project success criteria which are the measures for determining whether a project is successful or not. In the traditional view the measures of project success are scope, time, cost, quality, resources, customer satisfaction, stakeholder satisfaction, realised benefits [32]. These success measures are referred in project audits or post-project reviews.

According to [51] the measures of agile project success are customer satisfaction, business value delivered, velocity, budget against actual cost, planned against actual stories per iteration, planned against actual stories release dates, iteration burndown, defects in to production, burn-up chart, defects overtime, cycle time, release burndown, Work-in-process (WIP), defects resolution, customer retention, estimation accuracy, earned value, test pass/fail overtime, revenue/sales impact, cumulative flowchart, product utilization, individual hours per iteration and scope change in a release.

In this study the agile project success measures were designed using the VersionOne [51] agile project success criteria because they have been used in measuring agile project success.

H. AGILE PROJECT AUDITING

Most organizations are adopting agile project management to improve the success rates of IT projects. This adoption of agile requires organization changes in culture, mindset, behaviors and structure [19]. One of these organizational changes is how agile projects are audited. Auditing agile projects is necessary to increase the chances of delivering successful IT projects in the organization [36], [41]. Project auditing is currently undergoing a fundamental change due

to emerging technologies associated with the Fourth Industrial Revolution. This implies that the methods for auditing agile projects require a different audit process [3]. Auditors should be involved in the entire software development process.

Various studies have been done on agile project auditing. [35] proposed an auditing model for ISO 9001 traceability requirements that is applicable in the agile (XP) environment. The model is based on evaluation theory and includes the use of several auditing “yardsticks” derived from the principles of engineering design. Their model consists of two major categories of auditing criteria, namely engineering criteria (coverage and design of the traceability method) and management criteria (monitoring and identification of the traceability method). Each auditing criterion consists of several auditing yardsticks, which focus on the evidence that can be extracted to demonstrate process conformity to the ISO 9001 traceability requirements. The auditing model for ISO 9001 traceability requirements does not provide audit processes for auditing agile projects.

Reference [25] proposed an agile methodology audit model which comprises basic audit checkpoints at application system level. These checkpoints include requirement definition, release plan, sprint launch, analysis/design, development, test and sprint termination. Reference [34] studied agility in auditing and investigated whether Scrum could improve the audit process. They proposed a Scrum framework which includes the Scrum culture, mindset or values, skills, processes and structure. They found that the use of Scrum for auditing teams offers a new paradigm that moves from more rigid and reactive planned auditing to a new emphasis on iterative identification of auditing tasks in response to changing conditions. They argue that one way to introduce agility in a project-based organization is to adopt Scrum to allow organizational teams to review, reflect, learn and adapt. However, the framework does not provide audit processes for auditing agile projects.

According to Deloitte [14], auditing agile projects can include documentation of user stories, sprints, meeting minutes, checkboxes or notes on the story, defined acceptance criteria, an indication of when the solution is ready for deployment, business requirements and changes made to the requirements throughout the project, sign-offs, controls designed and built into the system, risks and applicable controls related to that functionality of the product and knowledge of agile among the agile team. Agile projects should be audited at the beginning of the project rather than at the end. Auditing agile projects throughout the development process helps to detect and prevent anomalies earlier, mitigate risks and add value.

Another study related to auditing agile projects was done by Gibbons *et al.* [20], who created a framework to audit the agile teams focused on the XP environment. The framework monitors agile teams on adherence to agile practices during solution development and backlog delivery. The framework measures the number of stories and iterations delivered by the agile team as well as frequency of practice adherence.

However, the framework does not provide audit processes for auditing agile projects. Agile audit frameworks found in the literature review are compared in Fig. 1.

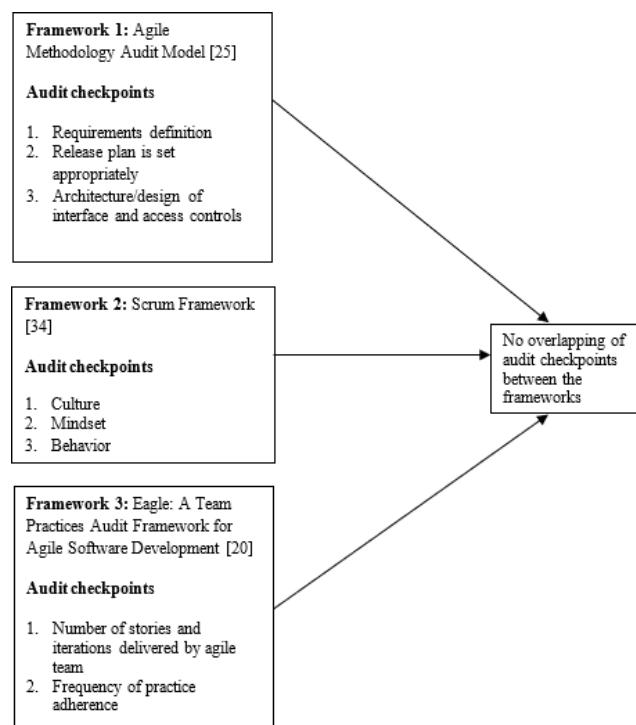


FIGURE 1. Comparison of agile audit frameworks.

The comparison of agile audit frameworks reveals that there are no overlapping audit items between the framework. The existing frameworks are not applicable for auditing Scrum IT project because they have not proposed audit processes for auditing agile project management which is implemented using Scrum methodology. It is needed to have a new framework for auditing Scrum IT project because there is a lack of the framework specific for Scrum methodology.

There are limited studies on auditing agile projects. This means that auditing of agile projects is still a new area of research. The related studies do not propose a framework which can be used to audit agile projects that are implemented using Scrum methodology.

The research question was whether agile projects can continuously be audited to improve their success rates in the organizations. There was therefore a need for a framework for auditing agile projects that can be used by project practitioners to successfully deliver agile projects in their organizations. The framework can be used by auditors to audit agile projects.

I. CONCEPTUAL FRAMEWORK DEVELOPMENT

The procedure of conceptual framework analysis [45] was used to develop the conceptual framework. The procedure composed of the following phases:

1) PHASE 1: MAPPING THE SELECTED DATA SOURCES

The search for related publications was guided by keywords such as ‘agile project management’, ‘agile methods’, ‘agile project audit’, ‘agile project success’, ‘software quality assurance in agile project’, ‘project governance’, “agile software development’. Major databases were used to search for related articles, such as those provided by major publishers:

- Scopus (www.scopus.com),
- Elsevier (www.sciencedirect.com),
- Emerald (www.emeraldinsight.com),
- Springer (www.springerlink.com),
- Wiley (www.wiley.com).

The keyword ‘auditing agile project’ was searched from websites such as PWC (www.pwc.com), Deloitte (www.deloitte.com). The books on agile project management were also selected. A total of 47 data sources focused on the research keywords were identified.

2) PHASE 2: EXTENSIVE READING AND CATEGORIZING OF THE SELECTED DATA

This phase aimed at reading each article and categorizing the selected data. Descriptive dimensions were used to classify the papers. The content of the paper was further accessed by means of descriptive analysis: (i) how is the distribution of publications of articles related to auditing agile project across time period, (ii) what research methodological are applied? (iii) which dimensions of auditing agile project are addressed?

Descriptive Analysis: The distribution of publications across the time period was assessed. The body of literature identified 47 papers which were published in the period (1998-2019). The assessment of specific papers on auditing agile project found that the first published papers were in year 2013 [25], [35]. Other publications found in year 2018 [34] and 2019 [3], [14], [20], [36], [41]. A total of eight papers were published on auditing agile projects from 2013 to 2019. None of these eight papers have come with the framework for auditing agile projects. Research methodologies applied were differentiated as: (i) surveys, (ii) case studies, (iii) theoretical and conceptual papers, (iv) literature reviews, and (v) modelling papers. In the 47 identified papers, survey account for 26 of the papers, while 3 modelling papers, nine literature reviews, three theoretical and conceptual papers, and case studies account for 6 of the papers. The dimensions addressed on auditing agile project are as shown in the table 2.

3) PHASE 3: IDENTIFYING AND NAMING CONCEPTS

This phase involved reading and reread the selected data and discover concepts from literature. The seven concepts were identified after analysing the dimensions found in phase 2. The identified concepts were:

- Concept 1: Agile values and guiding principles
- Concept 2: Agile project management
- Concept 3: Agile methods
- Concept 4: Project governance

TABLE 2. Categories of the selected data.

Dimension	Reference	Number of papers
Project governance	[1], [6], [18], [33]	4
Agile project success	[2], [7], [8], [28],[32], [47], [49]	7
Agile project audit	[3], [14], [25], [34], [35], [36], [41]	7
Agile methods and software development	[4], [5], [10], [12], [16], [21], [27], [29], [50]	9
Agile project management	[9], [22], [24], [51],[52]	5
Agile values and guiding principles	[19], [20]	2
Software quality assurance in agile project	[17], [26], [31], [37], [43], [44], [46], [48], [53]	9
IT project management	[23], [30], [32], [42]	4
Total		47

Concept 5: Agile project audit

Concept 6: Software quality assurance in agile project

Concept 7: Agile project success

4) PHASE 4: DECONSTRUCTING AND CATEGORIZING CONCEPTS

The aim of this phase was to deconstruct each concept to: (i) identify its main attributes, characteristics, assumptions and role; (ii) organize and categorize the concepts according to their features, and ontological, epistemological and methodological. The results of deconstructing and categorizing concepts are as shown in table 3.

5) PHASE 5: INTEGRATING CONCEPTS

This phase aimed at integrating and grouping together concepts that have similarities to a new concept. This phase reduced the number of concepts and allowed to have reasonable number of concepts. The integrated concepts are as shown in Fig. 2.

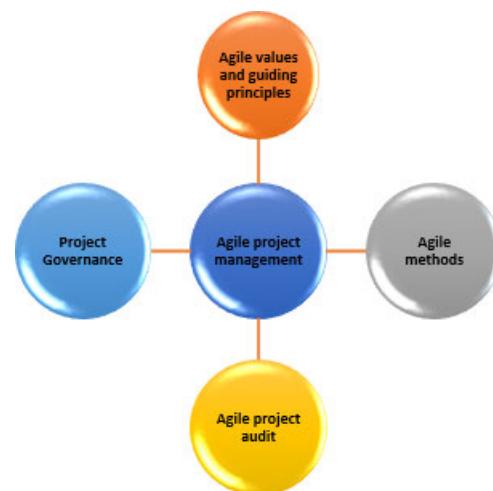


FIGURE 2. Integration of concepts.

TABLE 3. Results of deconstructing and categorizing concepts.

Name of concepts	Description of concept	Categorizing concept role	References
Agile values and guiding principles	Agile project management is guided by four agile values and twelve principles to improve software development processes	Ontological concept	[19], [20]
Agile project management	It is a conceptual project management framework for undertaking software development projects.	Methodological concept	[9], [22], [24], [51], [52]
Agile methods	These are approaches to project management that promote continuous iteration of development and testing throughout the software development lifecycle. For example, Scrum methodology.	Methodological concept	[4], [5], [10], [12], [16], [21], [27], [29], [50]
Project governance	It oversees implementation of agile project activities and provides a framework for decision making throughout the project.	Methodological concept	[1], [6], [18], [33]
Agile project audit	Audit agile project to ensure compliance, identify risks, internal controls and success completion.	Methodological concept	[3], [14], [16], [25], [34], [35], [36], [40]
Software quality assurance in agile project	It is a planned and systematic approach to the evaluation of the quality of and adherence to software product standards, processes, and procedure.	Methodological concept	[17], [26], [31], [37], [43], [44], [46], [48], [53]
Agile project success	Agile project success criteria have been used in measuring agile project success.	Methodological concept	[2], [7], [8], [28], [32], [47], [49]

6) PHASE 6: SYNTHESIS, RESYNTHESIS AND MAKING IT ALL MAKE SENSE

This phase aimed at synthesizing the identified concepts and drawing conclusion. Agile project management has to be adhered to agile values and guiding principles [19], [20]. Project governance monitors agile project progress throughout its implementation and provides a framework for decision making. Agile project audit provides assurance and enables the sponsor to have confidence that the project governance is working, the project is being managed as intended and be successfully completed as well as examine compliance, risk management and internal controls. There are various agile methods such as scrum, eXtreme programming, Kanban. Auditing agile project has to focus in a particular agile method because each agile method has different processes. This study focused on scrum methodology which is the commonly used method in agile project management [50], [51].

7) PHASE 7: VALIDATING THE CONCEPTUAL FRAMEWORK

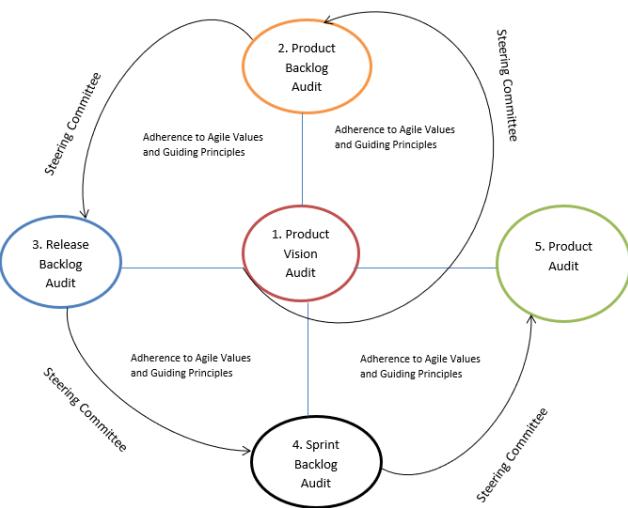
Validating the conceptual framework used subject matter experts. Agile project management experts from the University of Johannesburg's Department of Applied Information

Systems reviewed the framework and provided feedback. The comments were used to improve the framework. The experts also reviewed the questionnaire items to ensure its content validity. The experts provided useful reviews which were incorporated into the final survey questionnaire before administering it to a larger sample size.

The conceptual framework for auditing agile projects is discussed in the next section.

III. CONCEPTUAL FRAMEWORK FOR AUDITING AGILE PROJECTS

This section presents a conceptual framework for auditing agile projects (Fig. 3), which was developed and validated among IT professionals in South Africa.

**FIGURE 3.** Conceptual framework for auditing agile projects.

The conceptual framework for auditing agile projects can assist project auditors in auditing agile projects. The framework may improve the success rates of IT projects in the organization.

Agile encompasses various methodologies, but most of the organizations use scrum methodology [50], [51]. This research reviews scrum methodology to come up with the audit processes. Scrum has five processes such as product vision, product backlog, release planning, spring backlog and potentially shippable product to customer. Each process has number of activities which are implemented in iteration manner. These processes were also used to identify components of the framework and audit process items. The conceptual framework in Fig. 3 comprises with the following components:

- **Product vision audit:** Audit processes which can be used to audit agile projects are examine the created product vision [9], establish a steering committee, identify stakeholders, develop epics (user stories) and user story acceptance criteria and train the Scrum team and stakeholders on agile values and guiding principles [6], [14], [18], [20], [25], [33].

- **Product backlog audit:** The audit processes examine developed product requirements, minutes of the meeting where product requirements were reviewed and approved and train the Scrum master, Scrum team and stakeholders on product requirements [9], [14], [20], [25], [34].
- **Release backlog audit:** The audit processes examine the plan and schedule for multiple sprints and the minutes of the meeting where the length of the iterations was determined and release plans that were reviewed and approved [9], [25].
- **Sprint backlog audit:** The audit processes are examine developed sprint requirements, examine minutes of the meeting where sprint requirements were reviewed and approved, sprint objectives were defined, sprint tasks were outlined and estimates were calculated, hold daily standups, develop a Scrum team task schedule plan, change requests for sprint tasks, Scrum board to monitor progress, and examine sprint progress reports, sprint retrospective reports, product acceptance criteria, burn-down chart and effective use of the product [9], [34], [35].
- **Product audit:** The audit processes examine product deliverables acceptance report, formal working deliverables agreement, project retrospective, project closed contract and product support and maintenance agreement [9], [14], [25].
- **Steering committee:** The steering committee is a project governance mechanism which oversees agile project progress, provides project support and guidance, monitors project performance, controls project implementation activities and provides a framework for decision making throughout the implementation of the agile project [6], [18], [32], [33].
- **Adherence to agile values and guiding principles:** The Agile Manifesto consists of two components, namely values and guiding principles [5]. In managing and implementing agile projects, project stakeholders should adhere to agile values and guiding principles [20].

IV. METHODOLOGY

A. DATA COLLECTION

In the literature there are various validation techniques applied to qualitative and quantitative research methods. Validation techniques used in qualitative research include case studies, ethnography, focus groups and interviews. While quantitative research applied survey questionnaires, experiments, observations, content analysis. This research adopted questionnaire as a validation technique because large amounts of information can be collected from a larger sample size at a relative low cost. Questionnaire also provides the same questions to respondents and maintains standardization in gathering information [15]. The research used a quantitative research method and data were collected through a structured survey questionnaire. The questionnaire aimed at

answering the research questions in relation to auditing agile projects in the organization. The survey instrument was pre-tested to assess content validity, the results were reviewed, and changes were incorporated into the final questionnaire. The online survey questionnaire was distributed using convenience sampling. Only 77 samples were valid and completed by IT professionals from South Africa who were involved in managing and implementing agile projects in the organization.

B. RELIABILITY TESTS

Cronbach's alpha coefficient was used to test the reliability of the questionnaire and was calculated for the five audit processes. The results in table 4 indicate that Cronbach's alpha coefficient was above 0.7, which means that there was internal consistency and good reliability [13].

TABLE 4. Cronbach's alpha reliability test results.

Audit process	No. of items	Cronbach's alpha Coefficient
Product vision audit	12	0.879
Product backlog audit	9	0.924
Release backlog audit	4	0.811
Sprint backlog audit	16	0.929
Product audit	5	0.748

V. RESULTS

The survey results are presented in descriptive analysis and correlation analysis.

A. DESCRIPTIVE ANALYSIS

A total of 77 complete responses were received from IT professionals in South Africa, as shown in table 5. A profile of the respondents indicated that 37.7% were project managers, 15.6% were Scrum developers and 13% were business analysts.

TABLE 5. Respondent profile.

Type of respondent	Frequency	Valid per cent
Sponsor	1	1.3
Project manager	29	37.7
Product owner	2	2.6
Chief Scrum master	8	10.4
Program Scrum master	1	1.3
Scrum developer	12	15.6
Business analyst	10	13.0
Tester	4	5.2
Stakeholder	2	2.6
Engineer	1	1.3
User	7	9.0
Total	77	100.0

As illustrated in table 6, most of the respondents had been using an agile approach in managing and implementing

projects for between 3 and 6 years. Most of the project managers were involved in managing agile projects in their organizations.

TABLE 6. Agile approach in managing and implementing projects.

	Period of using agile approach in managing and implementing projects				
	Less than 3 years	Between 3 and 6 years	More than 6 years	Total	
Respondents' role in agile project management	Sponsor	0	1	0	1
	Project manager	4	18	7	29
	Product owner	0	1	1	2
	Chief Scrum master	0	5	3	8
	Program Scrum master	0	1	0	1
	Scrum developer	2	8	2	12
	Business analyst	5	4	1	10
	Tester	0	4	0	4
	Stakeholder	1	1	0	2
	Engineer	0	1	0	1
	User	3	4	0	7
Total		15	48	14	77

Table 7 presents the size of the Scrum team against the average number of sprints in a release. The results indicate that most of the Scrum teams had between 5 and 10 members. Scrum teams with between 5 and 10 members could also have between 5 and 10 sprints in a release.

TABLE 7. Size of scrum team against average number of sprints in a release.

	Size of Scrum team				Total	
	< 5 members	Between 5 & 10 members	Between 10 & 15 members	> 15 members		
Average number of sprints	< 5	6	5	0	1	12
	Between 5 & 10	1	28	3	0	32
	Between 10 & 15	1	27	2	0	30
	Between 15 & 20	0	0	1	0	1
	> 20	0	1	1	0	2
	Total	8	61	7	1	77

The results in table 8 indicate that the average duration of a Scrum sprint was between 8 and 12 weeks. The average number of sprints in a release was between 5 and 10 sprints. This means that when the average duration of Scrum sprints was between 8 and 12 weeks, the average number of sprints in a release was between 5 and 10 sprints.

TABLE 8. Average duration of scrum sprints against average number of sprints in a release.

	Average duration of Scrub sprints				Total
	2-4 weeks	4-8 weeks	8-12 weeks	> 12 weeks	
< 5 sprints	6	5	1	0	12
Between 5 and 10	5	4	23	0	32
Between 10 and 15	2	5	23	0	30
Between 15 and 20	0	0	1	0	1
> 20	1	0	0	1	2
Total	14	14	48	1	77

There are various agile methods used in managing projects. Scrum (75%) was the most common agile method used by organizations in South Africa, as shown in Fig. 4. According to VersionOne [51], 54% of their respondents used Scrum as a method of managing projects. These results mean that most organizations worldwide, including South Africa, use Scrum in managing and implementing projects. However, more South African organizations (75%) use Scrum as a method compared to the rest of the world [51].

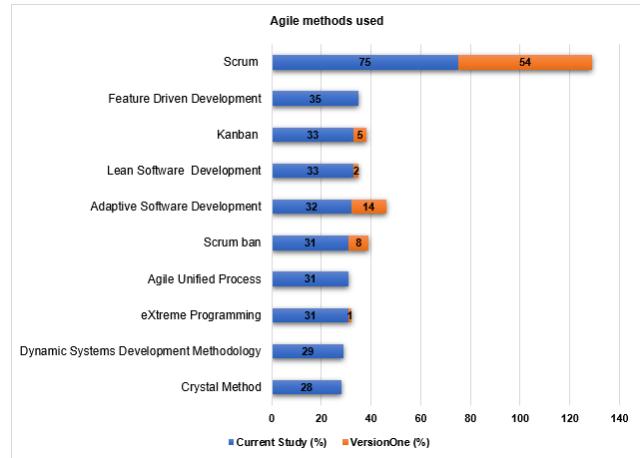
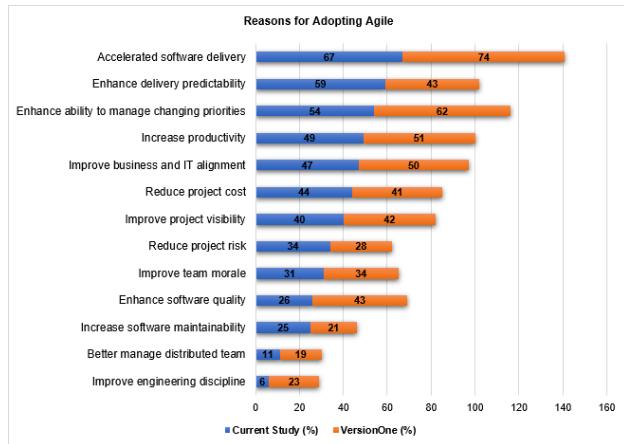
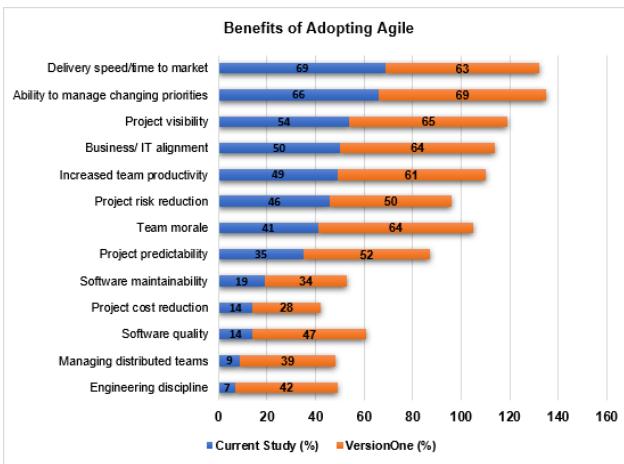


FIGURE 4. Agile methods used in managing projects.

As illustrated in Fig. 5, most respondents indicated that the reasons for adopting agile were accelerated software delivery in their organization (67%), enhanced delivery predictability (59%) and enhanced ability to manage changing abilities (54%). On the other hand, reasons for adopting agile were less about improving engineering discipline (6%), managing a distributed team (11%) and increasing software maintainability (25%). The reasons for adopting agile for South Africa differ from those of the global survey [51], but both surveys have identified reasons for adopting agile.

As shown in Fig. 6, most respondents indicated that the benefits of adopting agile were delivery speed/time to market (69%), ability to manage changing priorities (66%), project visibility (54%) and business/IT alignment (50%). The results

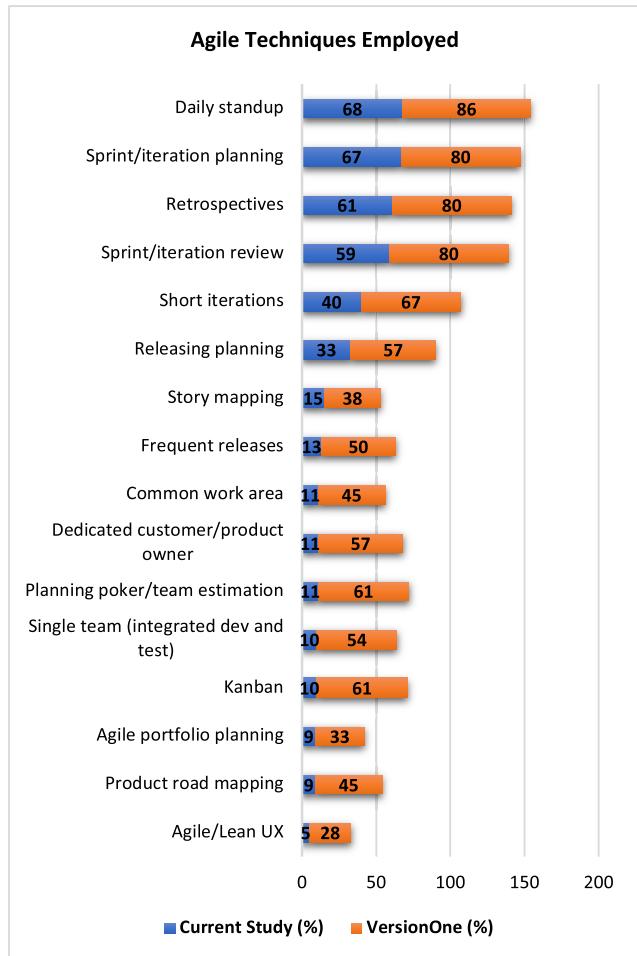
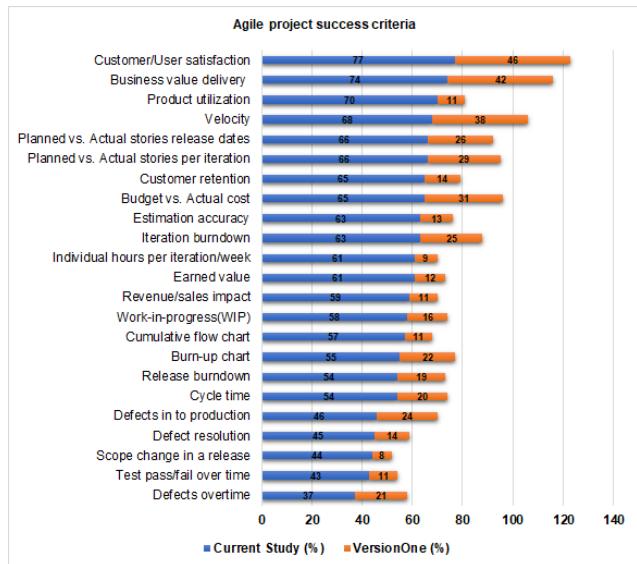
**FIGURE 5.** Reasons for adopting agile.**FIGURE 6.** Benefits of adopting agile.

also indicate that the benefits of adopting agile were less about engineering discipline (7%), managing distributed teams (9%), reducing project cost (14%) and software quality (14%). These results show that benefits of adopting agile in South Africa differ from those of the global survey [51].

As shown in Fig. 7, the common agile techniques employed in the organizations in South Africa were daily startup (68%), sprint/iteration planning (67%), retrospectives (61%), sprint/iteration review (59%) and short iterations (40%).

These results indicate that the agile techniques most employed in the global and South African organizations are daily startup, sprint/iteration planning, retrospectives, sprint/iteration review and short iterations.

The measures in Fig. 8 were used as success criteria to measure agile project success. The results in Fig. 8 on how organizations measure success of agile projects, respondents indicated that customer/user satisfaction (77%), business value delivered (74%), velocity (68%), planned vs. actual story release dates (66%) and planned vs. actual stories per iteration (66%) were the most measures of agile project success in South Africa.

**FIGURE 7.** Agile techniques employed.**FIGURE 8.** Agile project success criteria.

These results mean that the most common criteria used to measure agile project success in South Africa and the rest of the world [51] are customer/user satisfaction, business value

delivered, velocity, planned vs. actual story release dates and planned vs. actual stories per iteration.

Agile project success was measured using the weights in percentage (%) for 22 success criteria against audit processes as shown in table 9. These weights (%) were obtained from respondents' perceptions on relationship between agile project success criteria and audit processes (46 items). Table 9 results indicated that Customer/ User satisfaction (72%) had the highest weight (%) between agile project success criteria and audit processes followed by Revenue/ Sales impact (49%), Budget Vs. Actual cost (39%), and Individual hours per iteration/week (39%).

TABLE 9. Analysis results for agile project success criteria and audit processes.

Agile Project Success Criteria	Percentage (%)
Customer / User satisfaction	72
Revenue /Sales impact	49
Budget vs. Actual cost	39
Individual hours per iteration/week	39
Cumulative flow chart	33
Iteration burndown	26
Cycle time	26
Planned vs. actual stories per iteration	24
Earned value	22
Business value delivered	20
Release burndown	20
Product utilization	20
Planned vs. actual stories release dates	20
Customer retention	15
Velocity	11
Work-in-progress	11
Test/pass fail over time	11
Estimation accuracy	9
Scope change in a release	9
Defect resolution	4
Defect in to production	2
Defect over time	2

B. CORRELATION ANALYSIS

A Pearson correlation analysis test was performed to determine whether there was any significant relationship between the audit processes and agile project success. Cohen [11] suggests guidelines to interpret the relationship values between 0 and 1. According to Pallant [38], these guidelines apply whether or not the r value is positive or negative. $r = 0.100$ to 0.290 indicates a small or weak relationship, $r = 0.300$ to 0.490 indicates a medium or moderate relationship and $r = 0.500$ to 1.000 indicates a large or strong relationship.

A correlation analysis test was then performed between the proposed audit processes and extent to which agile projects implemented are successful in the organization. These audit processes were for the product vision, product backlog, release backlog, sprint backlog and product deliverables of the scrum methodology. The analysis aimed at determining whether there was a relationship between agile project success and those audit processes.

The items in each audit process were derived from the literature reviews and scrum methodology processes. In this

study, measures were designed from the literature review on agile project management and scrum methodology processes. A 5-point Likert scale ranging from "Strongly disagree" to "Strongly agree" was used to measure the 46 items. In the correlation analysis project success was measured using the extent to which the audit processes were implemented better in managing agile projects. The respondents were asked to use the most recent agile project that they were involved in. The respondents used the Likert scale to rank the audit processes that can be used to audit agile projects. The ranking was done according to the importance of the audit process.

Correlation analysis results are discussed in the following sections.

1) PRODUCT VISION AUDIT PROCESSES

Table 10 presents the results of the correlation analysis between product vision audit processes and agile project success.

TABLE 10. Correlation analysis results for the product vision audit processes.

Audit process	Extent to which agile projects implemented are successful in the organization	
	Pearson correlation	Sig. (2-tailed)
PV1: Created product vision that is agreed with a scrum team	.175	.135
PV2: Establishment of Steering Committee	.262*	.024
PV3: Identified Product Owner	.029	.807
PV4: Identified Scrum Master	.315**	.006
PV5: Identified stakeholders	.326**	.005
PV6: Identified scrum team	.193	.099
PV7: Conducted training to Scrum team and stakeholders on agile values	.326**	.005
PV8: Conducted training to Scrum team and stakeholders on agile guiding principles	.385**	.001
PV9: Development of epics (user stories)	.319**	.006
PV10: Held user group meetings to discuss appropriate epics	.596**	.000
PV11: Created user story acceptance criteria	.478**	.000
PV12: Ensured adherence to agile values and guiding principles	.027	.819

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

N=74

The results for Pearson's correlation coefficient (r) as shown in table 10 indicated, there was a statistically weak positive relationship between extent to which agile

projects implemented were successful in the organization and the establishment of a steering committee ($r = 0.262$, $N = 74$, $p < .05$). This finding seems to suggest that the establishment of a steering committee (as a project governance) has some positive role in influencing project success. The finding is in line with findings from a study by [6], [8], [32], [33] which showed that project governance monitor project progress, provided guidance and decision making throughout the project.

A moderate significant correlation was indicated between extent to which agile projects implemented were successful in the organization and the identification of a Scrum team ($r = 0.315$, $N = 74$, $p < .01$). This result implies that Scrum team develops the product and ensures that it is successful delivered to customer. This finding is consistent with findings from a study by [14], [20], [25] which indicated that identification of Scrum team is important in the development of product. Thus, identification of Scrum team in the product vision of the scrum methodology influences agile project success.

There was a statistically moderate positive correlation between extent to which agile projects implemented were successful in the organization and conducted training for the Scrum team and stakeholders on agile values ($r = 0.326$, $N = 74$, $p < .01$), as well as extent to which agile projects implemented were successful in the organization and conducted training for the Scrum team and stakeholders on agile guiding principles ($r = 0.385$, $N = 74$, $p < 0.1$). These findings align with findings from [14], [20], [34] which indicated that training scrum team and stakeholders on agile values and guiding principles is important in agile project management. These results indicate that emphasis on training and continuous learning to Scrum team and stakeholders during the agile project influence project success. The results of Pearson's correlation coefficient test on extent to which agile projects implemented are successful in the organization and development of epics showed a moderate correlation ($r = 0.319$, $N = 74$, $p < .01$). This result implies that in the development of product backlog requirements are gathered using user stories. These requirements are updated throughout the product development and are communicated to project team and stakeholders which have a positive role to play in influencing project success [2], [9]. A moderate significant correlation was indicated between extent to which agile projects implemented are successful in the organization and created user story acceptance criteria ($r = 0.478$, $N = 74$, $p < .01$). The results show that creation of user story acceptance criteria have important role to play in influencing agile project success.

There was a statistically significant strong positive relationship between extent to which agile projects implemented were successful in the organization and holding user group meetings to discuss appropriate epics ($r = 0.596$, $N = 74$, $p < .01$). This result had the highest correlation coefficient, implying that holding user group meetings to discuss

appropriate epics has a significant role in influencing agile project success.

There was no correlation between agile project success and audit process for PV1, PV3, PV6 and PV12.

2) PRODUCT BACKLOG AUDIT PROCESSES

Table 11 presents the results of the correlation analysis between product backlog audit processes and agile project success.

TABLE 11. Correlation analysis results for product backlog audit processes.

Audit process	Extent to which agile projects implemented are successful in the organization	
	Pearson correlation	Sig. (2-tailed)
PB1: A developed product requirements which is aligned with a product vision	.106	.374
PB2: There are minutes of a meeting that reviewed and approved product requirements document	.195	.099
PB3: There is a signed agreement to show that Product Owner owns a product backlog	.153	.196
PB4: Created product Backlog change request	.271*	.020
PB5: Established Product Backlog approval document	.249*	.020
PB7: Conducted training to Scrum Master on product requirements	.271*	.020
PB8: Conducted training to Scrum team on product requirements	.241*	.040
PB9: There are sprint goals which are presented by the Product Owner	.000	1.000

*. Correlation is significant at the 0.05 level (2-tailed).
N=73

As shown in table 11 there was statistically weak positive relationship between extent to which agile projects implemented were successful in the organization and created a product backlog change request ($r = 0.271$, $N = 73$, $p < .05$). This result indicates that creating a product backlog change request is somewhat important in influencing agile project success. A weak significant correlation was indicated between extent to which agile projects implemented were successful in the organization and the establishment of a product backlog approval document ($r = 0.249$, $N = 73$, $p < .05$). The product backlog (requirements) are used to develop the product and related deliverables. This finding aligns with findings from [9], [14], [25] which showed that product backlog requirements are used to develop the

potentially shippable product to customers. These requirements are updated throughout the project requiring to be approved [9]. The findings indicate that the establishment of a product backlog approval document influence agile project success.

There was a weak positive correlations between extent to which agile projects implemented were successful in the organization and conducted training to a Scrum master on product requirements ($r = 0.271, N = 73, p < .05$), as well as between extent to which agile projects implemented were successful in the organization and conducted training to a Scrum team on product requirements ($r = 0.241, N = 73, p < .05$). The results indicate that training a Scrum master and Scrum team on product requirements are somewhat important in influencing agile project success.

There was no correlation between agile project success and audit process PB1, PB2, PB3, PB6 and PB9.

3) RELEASE BACKLOG AUDIT PROCESSES

Table 12 presents the results of the correlation analysis between backlog audit processes and agile project success.

TABLE 12. Correlation analysis results for release backlog audit processes.

Audit process	Extent to which agile projects implemented are successful in the organization	
	Pearson correlation	Sig. (2-tailed)
RP1: Development of the release backlog which is aligned with the product backlog	.382**	.001
RP2: There is a developed release planning schedule for multiple sprints	.135	.256
RP3: There are minutes of the meeting that determined the length of the iterations and sprint meetings	.243*	.039
RP4: There are minutes of the meeting that reviewed and approved the release plan	.288*	.014

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
N=73

Table 12 shows that a moderate significant correlation was indicated between extent to which agile projects implemented are successful in the organization and the development of the release backlog which is aligned with the product backlog ($r = 0.382, N = 73, p < .01$). This finding is in line with [9] which indicated that the release planning should be aligned with a product backlog. This result implies that the development of the release backlog which is aligned with the product backlog has an important role to play in influencing agile project success.

There was a weak positive relationship between extent to which agile projects implemented are successful in the organization and existence of minutes of the meeting that determined the length of the iterations and sprint meetings ($r = 0.243, N = 73, p < .01$), as well as between extent to which agile projects implemented are successful in the organization and existence of minutes of the meeting that reviewed and approved the release plan ($r = 0.288, N = 73, p < .01$). This finding was also argued by [9], [25]. These results suggest that existence of minutes of the meeting that determined the length of the iterations and sprint meetings, as well as existence of minutes of the meeting that reviewed and approved the release plan play a positive role in influencing agile project success.

There was no correlation between agile project success and audit process RP2.

4) SPRINT BACKLOG AUDIT PROCESSES

Table 13 shows that most of the audit processes in the sprint backlog had moderate correlations.

Moderate significant correlations were found between extent to which agile projects implemented are successful in the organization and agile project success and the development of sprint requirements documents which are aligned with the product backlog requirements ($r = 0.456, N = 73, p < .01$), existence of minutes of the meeting that reviewed and approved sprint requirements documents ($r = 0.424, N = 73, p < .01$), existence of change requests for sprint tasks ($r = 0.311, N = 73, p < .01$), the updating and maintenance of the product backlog ($r = 0.436, N = 73, p < .01$), existence of the minutes of daily standup meetings ($r = 0.442, N = 73, p < .01$), a sprint blocks list ($r = 0.343, N = 73, p < .01$), existence of a sprint burndown chart to monitor the progress of the Scrum team ($r = 0.446, N = 73, p < .01$) and existence of a sprint retrospective report ($r = 0.459, N = 73, p < .01$). This finding is in line with findings from [9], [25] which indicated that minutes of daily standup meetings should be documented, to have sprint blocks list, using a sprint burndown chart to monitor the progress of the Scrum team. These results indicate that these audit processes play an important role in influencing agile project success.

On the other hand, there was a significant weak correlation between extent to which agile projects implemented are successful in the organization and existence of a signed agreement by the Scrum team to show their commitment to deliver the product requirements to all the sprints ($r = 0.284, N = 73, p < .05$). This result implies that the signed agreement by the Scrum team to show their commitment to deliver the product requirements to all the sprints plays a positive role in influencing agile project success.

A strong significant correlation was indicated between extent to which agile projects implemented are successful in the organization and existence of minutes of the sprint planning meeting that defined sprint objectives, outlined sprint tasks and calculated estimates ($r = 0.524,$

TABLE 13. Correlation analysis results for sprint backlog audit processes.

Audit process	Extent to which agile projects implemented are successful in the organization	
	Pearson correlation	Sig. (2-tailed)
SB1: A developed sprint requirements document which is aligned with the product backlog requirements	.456**	0.000
SB2: There are minutes of the meeting that reviewed and approved sprint requirements documents	.424**	0.000
SB3: There is a developed sprint team tasks schedule plan	.072	.547
SB4: There are assigned agreement by Scrum team to show their commitment to deliver the product requirements to all the sprints	.284*	0.015
SB5: There are minutes of the sprint planning meeting that defined sprint objectives, outline sprint tasks and calculate estimates	.524**	0.000
SB6: There is a change request for sprint tasks	.311**	0.007
SB7: An updated and maintained product backlog continuously	.436**	0.000
SB8.a: There are minutes of daily standup meetings	.442**	0.000
SB8.b: There are sprint progress reports	.119	.314
SB8.c: There is a sprint blocks list	.343**	0.003
SB8.d: There is a sprint burndown chart to monitor progress of the Scrum team	.446**	0.000
SB8.e: There is a scrum board used by scrum team to track its progress during sprint	.142	.231
SB9: There are sprint review reports	.194	.100
SB10: There is a sprint retrospective	.459**	0.000
SB11.a: There are product acceptance criteria	.072	.544
SB11.b: Customer is using the product	.157	.185

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

N=73

$N = 73, p < .01$). These findings align with the findings from [9] which indicated that it is important to have minutes of the meeting for sprint planning. This result means that existence of minutes of the sprint planning meeting that defined sprint objectives, outlined sprint tasks and calculated estimates has a significant role in influencing agile project success.

There was no correlation between agile project success and audit process SB3, SB8.b, SB8.e, SB9, SB11.a and SB11.b.

5) PRODUCT DELIVERABLES AUDIT PROCESSES

Table 14 presents correlation results for the product deliverables audit processes.

TABLE 14. Correlation analysis results for product deliverables audit processes.

Audit process	Extent to which agile projects implemented are successful in the organization	
	Pearson correlation	Sig. (2-tailed)
PR1: There are stakeholders' product deliverables acceptance reports	.196	.096
PR2: There is a formal working deliverables Agreement that documents the successful completion of the sprint	.089	.453
PR3: Establishment of project retrospective	.454**	.000
PR4: Closed a contract	.449**	.000
PR5: There is a project Retrospective	.013	.911

**. Correlation is significant at the 0.01 level (2-tailed). N=73

Table 14 shows that there was a statistically significant moderate positive relationship between extent to which agile projects implemented were successful in the organization and the establishment of a project retrospective ($r = 0.454, N = 73, p < .01$), as well as between extent to which agile projects implemented were successful in the organization and closed a contract ($r = 0.449, N = 73, p < .01$). This finding is in line with the findings from [9], [25] which showed that contract should be closed at the closure of agile project. These results indicate that the establishment of a project retrospective and closed a contract are important in influencing agile project success and cannot be overlooked.

There was no correlation between agile project success and audit process PR1, PR2 and PR5. The list of all audit processes are as shown in Appendix.

Correlation analysis results were then grouped into weak, moderate and strong relationships, as shown in table 15. Table 15 presents the top audit processes which can be used in auditing Scrum agile projects.

TABLE 15. Correlation groups of audit processes.

Correlation group	Audit process	r value
Strong	PV10: Held user group meetings to discuss appropriate epics	0.596
	SB5: There are minutes of the sprint planning meeting that defined sprint objectives, outline sprint tasks and calculate estimates	0.524
Weak	PV2: Established Steering Committee	0.262
	PB4: Created product Backlog change request	0.271
	PB5: Established Product Backlog approval document	0.249
	PB7: Conducted training to Scrum Master on product requirements	0.271
	PB8: Conducted training to Scrum team on product requirements	0.241
	RP3: There are minutes of the meetings that determined the length of the iterations and sprint meetings	0.243
	RP4: There are minutes of the meeting that reviewed and approved the release plan	0.288
	SB4: There is a signed agreement by the Scrum team to show their commitment to deliver the product requirements to all the sprints	0.284
	PV4: Identified Scrum master	0.315
Moderate	PV5: Identified stakeholders	0.326
	PV7: Training was conducted to Scrum team and stakeholders on agile values	0.326
	PV8: Conducted training to Scrum team and stakeholders on agile principles	0.385
	PV9: There are developed Epics (users' stories)	0.319
	PV11: There are created user story acceptance criteria	0.478
	RP1: There is a release backlog which is aligned with the product backlog	0.382
	SB1: Developed sprint requirements document which is aligned with the product backlog requirements	0.456
Strong	SB2: There are minutes of the meeting that reviewed and approved sprint requirements documents	0.424
	SB6: There is a change request for sprint tasks	0.311
	SB7: An updated and maintained product backlog continuously	0.436
	SB8.a: There are minutes of daily standup meetings	0.442
	SB8.c: There is a sprint blocks list	0.343
	SB8.d: There is a sprint burndown chart to monitor progress of the Scrum team	0.446
	SB10: There is a sprint retrospective	0.459
	PR3: There is a project retrospective	0.454
	PR4: A contract was closed	0.449

VI. DISCUSSION

Auditing an IT project identifies project risks earlier, triggers timely corrective actions, improves project performance and increases the chances of delivering a successful IT project in the organization [23], [32]. The research identified audit processes for auditing agile projects which are grouped into strong, moderate and weak audit processes, as shown in table 15. The research findings are discussed in the following section.

A. STRONG AGILE AUDIT PROCESSES

The key findings of the research are that user group meetings held to discuss appropriate epics and minutes of the

sprint planning meeting that defined sprint objectives, outlined sprint tasks and calculated estimates are important audit processes that influence agile project success. These findings corroborate those from the studies conducted by Deloitte [14] and Agnew [3] on auditing agile projects.

B. MODERATE AGILE AUDIT PROCESSES

The research found that identifying a Scrum master and stakeholders and training Scrum teams and stakeholders on agile values and guiding principles are important audit processes that influence agile project success. The same findings were highlighted from the studies by Deloitte [14] and Guerrero *et al.* [20] which indicated that knowledge of agile values and guiding principles allows Scrum teams and stakeholders to have adherence practice throughout agile project management.

The other key finding is that developed epics (users' stories), user acceptance criteria and a release backlog which is aligned with the product backlog are the important audit processes in achieving a successful agile project outcome. These findings corroborate those from studies by Deloitte [14] and Kim *et al.* [25] which indicate that developing user stories and acceptance criteria are the audit checkpoints.

The research also found that the developed sprint requirements document, minutes of the meeting that reviewed and approved the sprint requirements document, change requests for the sprint tasks and minutes of daily standups are important audit processes in implementing a successful agile project. These findings were highlighted in the studies of Deloitte [14], Qasaimeh and Abran [35] and Newmark *et al.* [34].

Other research findings are that the sprint blocks list, burndown chart to monitor the progress of the Scrum team, the sprint retrospective and the project retrospective are also important audit processes in achieving a successful agile project outcome [20], [25], [34].

C. WEAK AGILE AUDIT PROCESSES

The research found that the establishment of a steering committee to oversee the implementation of the project activities and provide a decision-making framework throughout the project life cycle is a success factor for the delivery of projects [6], [18], [33].

The key research findings are that training for the Scrum master and Scrum team on product requirements is an important audit process that influences agile project success. The product backlog approval document is an important audit process in achieving agile project success. These findings were highlighted in the study by Deloitte [14] on auditing agile projects.

The research found that training the Scrum master and Scrum team on product requirements is an important audit process in delivering a successful agile project. These findings support those from studies by Guerrero *et al.* [20] and Newmark *et al.* [34]. Ensuring that there are minutes of the meetings that determined the length of the iterations and

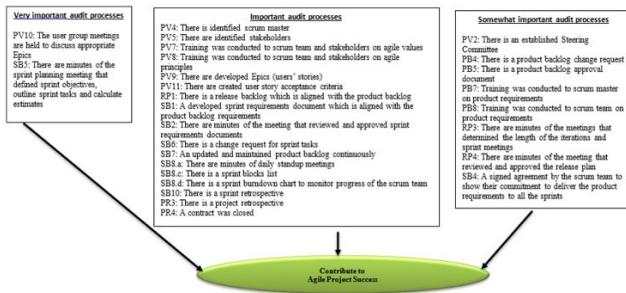


FIGURE 9. Audit processes contribute to agile project success.

sprint meetings, and minutes of the meetings that reviewed and approved the release plan is an important audit process in achieving a successful agile project outcome. The research also found that a signed agreement by the Scrum team to show their commitment to deliver the product requirements to all the sprints was one of the important audit processes in agile project success. These findings corroborate those of Deloitte [14]. The overall audit processes that contribute to agile project success are as shown in figure 9.

Based on the above findings, the audit processes in the strong group are very important in achieving a successful agile project outcome. The audit processes in the moderate group are important and those in the weak group are somewhat important in agile project success.

VII. CONCLUSIONS

A. CONTRIBUTIONS OF THE STUDY

The theoretical contribution of this study is firstly that it provides a conceptual framework for auditing agile projects. The framework introduces audit processes which have not been used in auditing agile projects. Secondly, there are limited studies on how to audit agile projects and auditing agile projects is a new area of research. Thirdly, none of the project management best practices and standards has provided guidance on agile project auditing. This study contributes to the body of knowledge on agile project auditing.

The practical contribution of this study firstly, it provides a tool on how to audit agile projects using scrum methodology. The project management practitioners from both public and private sector including auditors can use the framework to audit agile projects to improve success rates of agile projects. Secondly, this study contributes knowledge to the agile project management curriculum of the education and training institutions. These institutions can incorporate the concept of auditing agile projects in their project management curriculum to create competent agile project auditors in the IT industry.

B. LIMITATIONS OF THE STUDY

This study was limited because of the small sample size (77) drawn from South Africa. Further research is needed to collect data globally in a larger sample size. Secondly, this study focused on the Scrum agile method because it is the method commonly used in South Africa. There are

TABLE 16. List of all audit processes for auditing agile project.

Audit item	Audit process
Product Vision	<ul style="list-style-type: none"> • PV1: Created product vision that is agreed with a scrum team • PV2: Established Steering Committee • PV3: Identified Product Owner • PV4: Identified Scrum Master • PV5: Identified Stakeholders • PV6: Identified Scrum team • PV7: Conducted training to Scrum team and stakeholders on agile values • PV8: Conducted training to Scrum team and Stakeholders on agile guiding principles • PV9: Developed epics (user stories) • PV10: Held user group meetings to discuss appropriate epics • PV11: Created user story acceptance criteria • PV12: Ensured adherence to agile values and guiding principles
Product Backlog	<ul style="list-style-type: none"> • PB1: A developed product requirements which is aligned with a product vision • PB2: There are minutes of a meeting that reviewed and approved product requirements document • PB3: There is a signed agreement to show that Product Owner owns a product backlog • PB4: Created product Backlog change request • PB5: Established Product Backlog approval document • PB6: Training was conducted to stakeholders on product requirements • PB7: Conducted training to Scrum Master on product requirements • PB8: Conducted training to Scrum team on product requirements • PB9: There are sprint goals which are presented by the Product Owner
Release Backlog	<ul style="list-style-type: none"> • RP1: There is a release backlog which is aligned with the product backlog • RP2: There is a developed release planning schedule for multiple sprints • RP3: There are minutes of the meeting that determined the length of the iterations and sprint meetings • RP4: There are minutes of a meeting that reviewed and approved the release plan
Sprint backlog	<ul style="list-style-type: none"> • SB1: A developed sprint requirements document which is aligned with the product backlog requirements

various agile methods, and further studies may devise audit processes for different agile methods. A quantitative method using a survey questionnaire was used for data collection.

TABLE 16. (Continued.) List of all audit processes for auditing agile project.

	<ul style="list-style-type: none"> • SB2: There are minutes of the meeting that reviewed and approved sprint requirements documents • SB3: There is a developed sprint team tasks schedule plan • SB4: There is assigned agreement by Scrum team to show their commitment to deliver the product requirements to all the sprints • SB5: There are minutes of sprint planning meeting that defines sprint objectives, outlines sprint tasks and calculate estimates • SB6: There is a change request for sprint tasks • SB7: An updated and maintained product backlog continuously • SB8.a: There are minutes of daily standup meetings • SB8.b: There are sprint progress reports • SB8.c: There is sprint blocks list • SB8.d: There are sprint burndown chart to monitor progress of the scrum team • SB8.e: There is a scrum board used by scrum team to track its progress during sprint • SB9: There are sprint(s) review reports • SB10: There are sprint retrospective report • SB11.a: There are product acceptance Criteria • SB11.b: Customer is using the product
Product deliverable	<ul style="list-style-type: none"> • PR1: There are stakeholders' product deliverables acceptance reports • PR2: There is a formal working deliverables Agreement that documents the successful completion of the sprint • PR3: There is a project Retrospective • PR4: A contract was closed • PR5: There is a product support and maintenance agreement

Further studies can use a qualitative method or mixed method and compare the findings. There are limited studies on how to audit agile projects using scrum methodology. This study cannot be generalized to projects from other industries since the domain investigated was IT project management. Further studies are needed on how the proposed framework can be generalized in other industries. The survey questionnaire did not include type of institutions (either public or private), this is among the limitations of this study.

C. FUTURE RESEARCH

Some of the limitations of this study highlight the areas for further research. As agile project management is widely used, further research is needed to validate the conceptual

framework for auditing agile projects in more countries worldwide. Further research is also needed to compare the proposed work and justify performance and needs of work with recent studies and methods.

APPENDIX

See Table 16.

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