AOSIS

Measuring Agile software project success beyond the triple constraint

CrossMark
click for updates

Authors:
Emilia Kandengwa[1] ⓘ
Lucas T. Khoza[1] ⓘ

Affiliations:
[1]Department of Applied Information Systems, College of Business and Economics, University of Johannesburg, Johannesburg, South Africa

Corresponding author:
Lucas Khoza,
lucask@uj.ac.za

Background: The triple constraint – cost, scope and time – has been previously used to measure the success of traditional developed software projects. However, these triple constraints are no longer effective to measure the success of Agile software projects. Research shows that there are many other metrics that are being used to measure Agile methods beyond the triple constraint. Organisations are adopting Agile methods for a number of reasons which in turn are benefiting the software developing organisation in various ways. However, these software developing organisations still face challenges when adopting Agile methods.

Objective: This study aimed to investigate the different metrics to be considered when measuring Agile software project success beyond the triple constraints.

Method: Data were collected through an online survey. The population of interest included Agile specialists who are working on Agile software projects. The collected data were analysed using IBM SPSS version 26.

Results: Our results showed that software developing organisations implementing Agile software projects are using strategic metrics that bring value to software developing organisations when measuring their Agile software projects. One of the most cited metrics is customer satisfaction, which is believed to show more value because software projects cannot be accepted unless customers see the value in such projects.

Conclusion: There is a pragmatic shift in software development method, adoption and implementation. Organisations that are eager to see success are now shifting from using traditional methods to Agile methods of software development, and by doing so, success is inevitable.

Keywords: Agile software projects; software project success; projects; triple constraint; Agile metrics; business value; Agile adoption.

Introduction

Agile methods have been widely adopted by many software developing organisations in the implementation of software projects because they come with many advantages such as delivering successful projects on time and within budget (Pirro 2019; VersionOne Inc. 2020). Measuring the success of software project once it's brought to completion is a very important practice as it provides a learning opportunity for future projects and helps in assessing the effectiveness of the project. Organisations have been using the triple constraint to measure project's success (Barbalho, Da Silva & De Toledo 2017) but it was discovered that the triple constraint has no value if business success is not included (Marnewick 2012). Bannerman's framework was also introduced to measure the success of software projects but it was not suitable for Agile software projects (Bannerman 2008). This research aims to find out how Agile software project success is measured beyond the triple constraint. Agile metrics are criteria or standards that help software developing organisations to monitor how successful are the software projects that are being developed. These Agile metrics serve as key performance indicator's (KPI's) for guiding and improving the success of software projects (VersionOne Inc. 2020). The Agile metrics help software developing organisations to assess project success and their processes such as velocity (Ram, Rodriguez & Oivo 2018; VersionOne Inc. 2020). Software developing organisations use Agile metrics for tracking the progress of their software development and for measuring the quality of the delivered software project (Ram et al. 2018). Different metrics such as lean metric, Kanban metrics and common metrics can be used. Lean metrics are a typical set of procedures that are used to monitor the performance of the developed software. Kanban metrics measure team performance, and lastly, common metrics measures both processes, systems and the business value (Chowdhury 2021; Kupiainen, Mäntylä & Itkonen 2015; Ram et al. 2018). To identify metrics that are being used by software developing organisations to measure Agile success, the following main research question is addressed.

• How do organisations measure Agile project success beyond the triple constraint?

This article is structured as follows. Section 'Literature review' explores a theoretical foundation and literature around metrics used to measure Agile software projects, reasons for adopting Agile methods, benefits and disadvantages for adopting Agile. Section 'Methods' discusses the methods used in this research in terms of research design and data collection, validity and reliability as well. Results are presented in section four. Section five concludes the article and presents the recommendations and future research.

Literature review

Metrics to measure Agile software projects success

The most well-known metrics to measure software project success are the triple constraints – time, scope and cost (Barbalho et al. 2017). However, there are other metrics being used by software developing organisations to measure software project success beyond the triple constraint (Turner & Xue 2018). Bergmann and Karwowski (2018) identified *customer satisfaction* as one of the metrics used to measure success because it is important to satisfy customers. Customer satisfaction should be the highest priority, and working software should be the primary measure of success (Knaster & Leffingwell 2018). Customers are justified only when products are delivered to their requested features. Success is measured by comparing the net promoter score or sales figure versus the number of features delivered in a period of time. Bergmann (2018) observed that delivering business value is necessary in every project and it is measured by linking the product being developed to a value by having a business value score applied to the features to be delivered. On time delivery is another metric, and it is measured using burndown and burnup charts so that organisation gain visibility of the product being delivered on time (Thompson 2019). Quality assessment is performed to ensure if the product quality standards are met and testing trends help to test the quality of software projects (Thompson 2019). Bergmann (2018) said that productivity is used to measure Agile software project success and a burnup is used to measure productivity and it helps project managers to see what the project team is delivering. Predictability, process improvement, project visibility, project scope, budget versus scope are some of the metrics used to measure Agile software project success (VersionOne Inc. 2019). Other Agile metrics include software size estimation, burnout chart estimation and velocity. These metrics are used by software developing organisations to measure business value and customer satisfaction (Chowdhury 2021; Ram et al. 2018).

Bergmann and Karwowski (2018) reasoned that project visibility shares the updates and progress of the project to everyone, from the project team to stakeholders, and this is performed using a dependency chart that makes it easy for everyone to see what is needed to add or contribute to the success of the project. Velocity is used to assess predictability, and the velocity trend chart helps the project managers to predict how long it will take to finish the project (Forney 2019). Forney (2019) also believed that project managers compare budget versus actual cost to see if there is a difference so that they can create an accurate forecast of revenues and expenses. Metrics are very important in every project as they help to keep track of project and teams, and it is up for the organisations to choose metrics that are suitable for their Agile software projects depending on what they want to measure.

Different organisations will surely need metrics and a different approach in assessing what they stand to gain from any Agile project. Software developing organisations define software project success by how they manage scope, budget and timeline (Turner & Xue 2018). However, there are other metrics that are used to measure Agile project success beyond the triple constraints. Here is a summary of different metrics that are used to measure Agile software project success beyond the triple constraints.

Customer satisfaction

Customer satisfaction is one of the success measures, it is a priority to satisfy customer throughout all the stages of a project life cycle. Customer are satisfaction when products are delivered according to their requested features. Therefore, it is important to get feedback from customers at all stages of the Agile project so that it helps project managers and project team to see if they are delivering what the customer requested. Measuring the outcome of customer satisfaction includes looking at the net promoter score or sales figure versus number of features delivered in a period of time (Bergmann & Karwowski 2018).

Business value delivered

Bergmann (2018) mentioned that it is necessary to make sure that business value is delivered in every Agile project. Measuring value is prospective in the sense that the market inputs drive decision, and the value is often a best guess. Project managers need to link every product being developed to a value by having a business value score applied to the features to be delivered.

On time delivery

On time delivery is measured with regard to the expectations that will be delivered. Stakeholders expect a product or service to be delivered on or before the exact date as agreed upon whilst signing the documents. Burndown and burnup charts are metrics that help to measure success and gain visibility of what is actually being delivered and if it is on time (Thompson 2019).

Quality

Thompson (2019) explained that to confirm if the quality standards are met it is important to continuously test and inspect the development by monitoring testing trends

throughout the project life cycle. Testing trends help project managers and project team to see the progress around testing activities.

Productivity

Productivity is measured using a burnup chart because it provides a clear picture of which team is delivering what sort of an outcome. Looking at a burnup of count help managers to understand how much the team is delivering (Bergmann 2018).

Predictability

Forney (2019) stated that a predominant metric used to assess predictability is velocity trend. Velocity is used to generate metrics related to predictability. Velocity is a distance project team members travel to reach the sprint objectives. Velocity trend chart help project managers to understand how long it will take for the project team to finish the whole backlog, and the sprints help to measure the amount of work performed to reach the objectives.

Process improvement

To measure the improvement process, it is recommended to use cumulative flow chart. Cumulative flow charts help to explain how project work is flowing across the system development life cycle. With cumulative flow, it's easy to indicate where slowdowns may exist. Another metric that measures the success of process improvement is a cycle time. Cycle time helps with planning and predictability and helps project managers to view if adjustments are having an impact on productivity (Moura 2018).

Project visibility

Project updates and progress need to be shared across all platforms from the project team to the stakeholders using a dependency chart so that it becomes easy for everyone to see what is it they need to contribute towards the success of the project. The dependency chart makes it easy to visualise progress and measure success by comparing the overall progress against targeted plans of the project (Bergmann & Karwowski 2018).

Project scope

According to Moura (2018) project scope is about setting goals around what needs to be performed over a specific period of time. The scope is measured by tracking the status, and the use of real-time feedback towards the progress of a project is useful for the team. Projects rely on burndown charts or Kanban boards to check the progress of the project.

Budget versus actual cost

Project managers compare the budget of the project with the actual cost of the project to see if there is a difference and form a more accurate forecast of revenues and expenses. The comparison is made to measure if the project overlapped its actual budget or not (Forney 2019).

Reasons for adopting Agile methods

Organisations are adopting Agile methods for a number of reasons. The main reason being that it allows project teams to plan their work in short sprint cycles so that whenever priorities change it is not difficult to change plans (Flora 2018; VersionOne Inc. 2020). Improving project visibility is also another reason to adopt Agile methods because it adapt to changes. Agile methods increase productivity by satisfying customer's needs, and if productivity is increased, business is also improved (Ben Hachemi 2019). Quality is another reason why organisations are adopting Agile because Agile breaks down task into small manageable units to develop, test and release; and in all these stages, a customer can give feedback and the project team then makes necessary changes so that the final product will be of better quality. Agile methods reduce risk because it allows task to be delivered incrementally and also because of its lightweight framework (Brezočnik, Fister & Podgorelec 2018). Agile software project cuts cost by using back logs to prioritise and deliver a minimal product. Better management and distribution of teams and improving team morale are some of the reasons for adopting Agile. To keep the team morale spirit high, project managers need to listen to employees, recognise their efforts and communicate with the project team at every stage of the project (Mirza & Datta 2019).

The survey that was conducted by VersionOne Inc. (2019) as seen in Figure 1 shows reasons for adopting Agile methods. Small changes were observed. The top five reasons for adopting Agile methods are accelerating software delivery (74% compared with 75% in 2018), enhancing ability to manage changing priorities (62% compared with 64% in 2018), increasing productivity (51% compared with 55% in 2018), improving business/IT alignment (50% compared with 49% in 2018) and enhancing software quality (43% compared with 46% in 2018). The last three reasons for adopting Agile methods are improving engineering discipline (23% compared with 25% in 2018), increasing software maintainability (21% compared with 18% in 2018) and managing distributed teams better (19% compared with 17% in 2018).
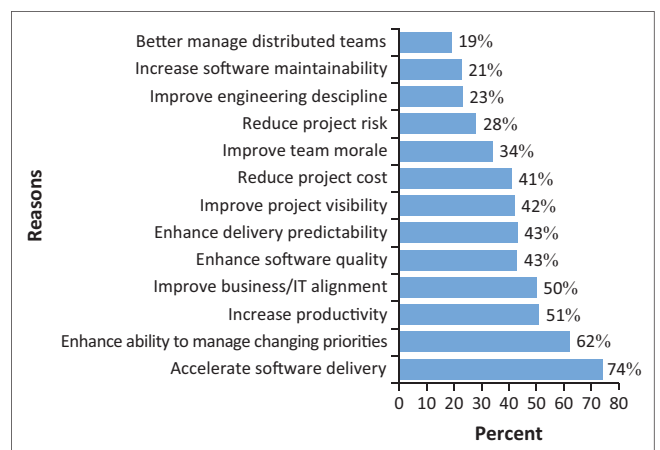
Source: VersionOne Inc. 2019.

FIGURE 1: Reasons for adopting Agile methods.

Benefits of adopting Agile methods

Software projects are benefiting from adopting Agile methods but the reasons and benefits of adopting Agile methods are almost the same; the only difference is that each factor plays its own role in a software project. According to IQbusiness (2019), improving collaboration and increasing visibility are some of the benefits of adopting Agile methods.

Improving collaboration encourages everyone involved in the project to work as team to solve project challenges.

Thomsen et al. (2019) emphasised on customer collaboration because constant customer collaboration brings a great opportunity by weighing the level of customer satisfaction throughout the life cycle of the project. Agile software projects adapt to changes, and this is a benefit because the ability to respond to changes is a competitive advantage in an organisation (Dikert, Paasivaara & Lassenius 2016). Improved team morale and increased productivity are also benefits of adopting Agile because if the project team is happy, they tend to increase productivity. Productivity is increased in Agile by motivating the team member and also training them so that they improve their skills (Biddle et al. 2018). Software maintainability, improved business and project cost reduction are some of the benefits of adopting Agile (Scaled Agile Inc. 2019; VersionOne Inc. 2019).

Agile methods are widely adopted and have proven to be benefiting to organisations over traditional methods in terms of cost and time (Khoza & Marnewick 2020; Nazir, Hasteer & Majumdar 2019). Organisations are appreciating the benefits achieved by adopting Agile methods. The use of Agile practices is producing benefits in the intended areas such as improving collaboration and increasing visibility (IQbusiness 2019). Improving collaboration in Agile project is a benefit because it encourages team members, stakeholders and clients to collaborate to solve project challenges. Agile emphasises on customer collaboration with a keen focus on highly skilled, motivated team in constant interaction with the product and the customer at every phase of the project. Constant customer collaboration brings a great opportunity by weighing the level of customer satisfaction throughout the life cycle of the project (Thomsen et al. 2019).

Improving the visibility in Agile projects produces amazing results because it allows transparency in projects by encouraging every member of the project team to be involved in knowing how the project is going and giving feedback at all stages. It gives the project members an opportunity to know what is happening in every stage; so that they can see the progress of the project through daily meetings, daily reviews and progress charts that indicate the progress (Tripp, Saltz & Turk 2018). One of the key benefits of Agile is that it is adaptive to change (Dikert et al. 2016). According to Raza and Waheed (2018), Agile software projects adapt and respond to change quickly. The ability to respond to change is a competitive advantage in any organisation. Unlike waterfall model, it does not allow any changes of requirements once the project development starts, but with Agile it is known for its flexibility. It allows changes to be made in the project development even if the initial planning has been completed. With Agile there is room to go back to a previous phases of project life cycle to make some changes.

Improved team morale and increased productivity are other benefits observed from Agile adoption (Mohamad 2018). Biddle et al. (2018) stated that team morale is one of the valuable assets any organisation can have. Without positivity and motivation within the project team, no matter how much investment on the paper, projects will not meet their expected success rate. In Agile methodology, team morale is improved by balancing workload on project teams, organising team building activities, encouraging each other to stay positive in times of setbacks and acknowledging project team members' efforts. And when the project team is happy and their morale is high, they tend to increase productivity. Increased team productivity is a process that involves increasing team members' satisfaction with their jobs and giving them the tools to effectively perform assigned tasks. Productivity is increased in Agile by continuously motivating team members, offering training opportunities so that the project team members improve their skills, communicating with team members giving updates of the project progress and also offering them bonus whenever they increase productivity so that on the next stage they will aim to increase the productivity even more (Zohner, Rockinger & Renner 2019). According to Sjøberg (2018), in an Agile environment, quality assurance is an added benefit in an organisation. Product quality gives customer satisfaction and meets the standards of the customer. Organisation must have quality control at all stages of the project process, and after the project is finished, project managers must match with project design specification to see if they have done justice to the project quality.

Challenges of adopting Agile methods

According to Gandomani and Nafchi (2016), organisational culture can be a challenge in Agile adoption; hence, management, the Agile team and the customers must be willing to change to fit in the Agile culture. In an Agile environment, teamwork plays an important role because Agile is people centred (Dikert et al. 2016; Gandomani & Nafchi 2016). The team's perception of Agile adoption is also a challenge for proper transitioning to Agile methods, and in order to address this, training should be provided and Agile culture should be embraced. This will therefore make the team understand the benefits of adopting Agile methods. Dikert et al. (2016) asserted that organisational culture is a serious issue, and once it is dealt with, there is an increased satisfaction in the deployment of Agile methods that becomes palpable. The organisational culture depicts how an organisation operates and therefore makes it difficult to easily accommodate the vagueness of agility in software development context. Successful organisations with the ability to adapt to change find it easy to adopt and adapt to an Agile.

Agile presents challenges that derail the best benefits. Some of the challenges of adopting Agile are as follows:

- **Insufficient Agile experience and insufficient training and education:** If the current staff do not have experience in Agile, it then becomes difficult to successfully adopt Agile because the development of Agile needs employees who are experienced to drive and enable new way of operating (Figalist et al. 2019).
- **Lack of management support:** Lack of management support affects middle management because if the top management fails to implement an Agile transformation plan that is strong, the middle management will then feel isolated and in turn it will result in resistance to adopt Agile (Hoda, Salleh & Grundy 2018).
- **Underestimating the amount of planning in Agile:** Dikert et al. (2016) and VersionOne Inc. (2020) observed that Agile planning is an ongoing process because requirement plans change throughout the development, and therefore, discipline is required to execute the whole planning.
- **Company philosophy at odds with core Agile values:** Culture change is the main dominant challenge in the implementation of Agile in any organisation. Starting small is important in ensuring that everyone in the organisation understands Agile concepts and benefits (Figalist et al. 2019).
- **General organisation resistance to change:** People are not willing to change due to inconsistent processes and practices across teams, pervasiveness of traditional development methods, lack of business/ customer availability, lack of collaboration and knowledge sharing and fragmented tooling and project related data (Dikert et al. 2016; VersionOne Inc. 2019).

Methods
Research design and data collection

This research collected data using a survey in the form of a questionnaire. The survey collected responses from a diverse set of organisations, and the target population consisted of individuals who are working closely with Agile projects. The questionnaire included five sections: (1) biographic information, (2) metrics used to measure Agile, (3) reasons for adopting Agile, (4) benefits of adopting Agile, and (5) challenges of adopting Agile. This research followed all the stages of the research process, that is research philosophy, research approach, research strategy, research choice, time horizons, and techniques and procedures (Saunders, Lewis & Thornhill 2019).

The research used a quantitative research method. A positivism philosophy was chosen because it allowed participants to express themselves without any distortion (Field 2018; Saunders et al. 2019). The research approach that was chosen was the deductive approach because this approach enables the researcher to get a closer understanding of the research context (Pallant 2016; Saunders et al. 2019).

When data were collected, it had to be into meaningful insight, and data preparation included three stages: data validation, data editing and data coding (Creswell & Clark 2018; Pallant 2016). IBM SPSS was the tool used to analyse the quantitative data collected.

Validity and reliability

The content validity was achieved through the literature that was applied in this research that covered all the research questions. Going through the different sources made the researcher to have a clear picture of other metrics used to measure Agile software project success beyond the triple constraint. Reliability was determined using Cronbach's alpha for each research question (Stephanie 2018). Table 1 shows that all reliability readings were above 0.7, which is acceptable (Stephanie 2018; Taber 2018), and it means that the instruments used in this study are reliable.

Research results
Biographic information

The majority of the respondents who participated in the survey were scrum masters (27%) followed by product owners who amounted to 26%. A total of 24% of respondents were Agile coaches and 19% being team members. Stakeholders and end users also participated in the survey but it was unfortunate that there was a lower response rate, each with 2% respondents. These results are almost the same as a study by VersionOne Inc. (2019), where it indicated that most respondents who participated in the survey were scrum masters (34%). It was surprising that product owners (26%) in this survey made it up the next largest group, whereas in IQbusiness (2019), it was revealed that there was a lower response rate from product owners (19%). It is evident from the findings that the majority of the respondents (52%) have 3 to 5 years of experience in Agile. In contrast, IQbusiness (2019) showed 40% of respondents having 2 to 5 years of experience in Agile, and this falls within the range of 3 to 5 years. A total of 21% respondents reported that they have 1 to 5 years of experience in Agile, and IQbusiness (2019) from the same experience of 1 to 2 years revealed equivalent results of 22%. Five years and more made it to the third group with 15% respondents. It was a relief to see that responses from respondents with less than a year experience had a lower response rate of 13% because it reassures that most respondents have more experience working with Agile projects, and therefore, the responses are more accurate as they are coming from respondents with much experience although it would have been more useful to gain more respondents with 5 and above years of experience.

TABLE 1: Reliability test and results.

Items tested	Cronbach's alpha results
Metrics used to measure Agile software project success	0.842
Reasons for adopting Agile methods	0.737
Benefits of adopting Agile methods	0.877
Challenges of adopting Agile methods	0.849

Metrics to measure Agile project success

Majority of respondents (69%) said that they used business value delivered metric to measure project success.

A total of 66% of the respondents were in favour of project visibility metric. Budget versus actual cost and customer satisfaction had the same percentage of respondents (60%). Metrics with the least number of respondents were predictability and product quality with 53% respondents. Figure 2 shows the metrics used to measure Agile project success beyond the triple constraint. The results have not been consistent with those reported by VersionOne Inc. (2019, 2020). There have been some changes regarding the top 3 metrics that have remained the same over the last few years, which are business value, customer user satisfaction and on time delivery. Our findings claim that organisations are now focused on business value, project visibility and process improvement as their top three metrics to measure project success. With the use of metrics, software developing organisations are able to measure and monitor the success of their software projects. The importance of these metrics includes continuity, self-management, delivery value and continuous improvement that runs throughout the entire process. Lean and Agile together can result in fast and bug-free application that leads to customer satisfaction. Metrics
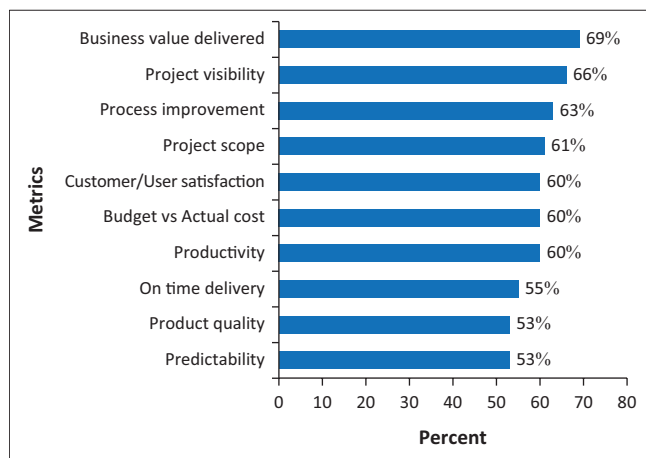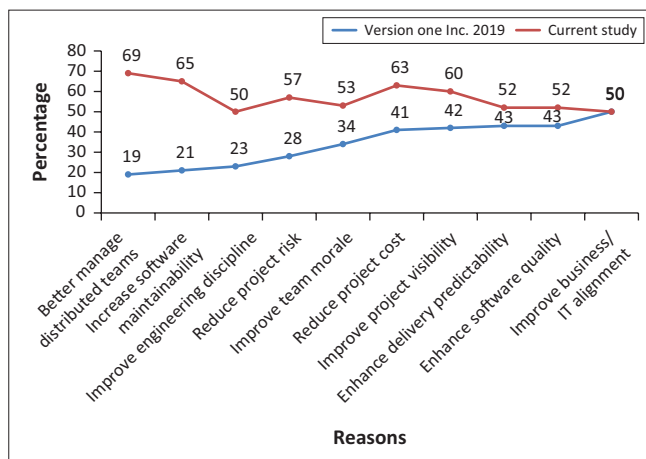
should be strategic in creating effective performance metrics, that is, traceable, accurate and simple to understand. Good metrics must be used by the team as opposed to those imposed by the management, surrounded by conversations not just number crunching, part of a specific experiment and used together with other metrics.

Reasons for adopting Agile methods

The top five main reasons stated by respondents on why they are adopting Agile in their software projects are that Agile manages the distributed teams better (69%), increases software maintainability (65%), reduces project cost (63%), improves project visibility (60%) and reduces project risk (57%). Comparing results of this survey and of VersionOne Inc. (2019), it can be confirmed that people working on Agile projects are beginning to see reasons for adopting Agile to benefit the success of their software projects. Figure 3 shows the reasons for adopting Agile.

As compared with VersionOne Inc. (2019), the results are showing an increase in interest when it comes to reasons for adopting Agile methods. This simply means that software developing organisations are seeing the need and the benefits of implementing Agile methods in their software projects.

Benefits for adopting Agile methods

By implementing Agile, respondents are experiencing improvements in project visibility (73%) and team morale (67%) both made up the biggest group of survey respondents. These results are equivalent to a study by IQbusiness (2019) where it stated that Agile practices are producing benefits in the intended areas such as increasing visibility (50%). Project risk reduction (64%) made up the next largest group and software quality had 61% responses. Comparing this survey with VersionOne (2019), there are some changes worth noticing such as the decrease in those reporting business/IT alignment (48%) had the lowest response rate, but in VersionOne (2019), it was in the top three benefits; it means that respondents are seeing less benefit in Business/IT alignment in their organisations. Figure 4 shows the benefits of adopting Agile.
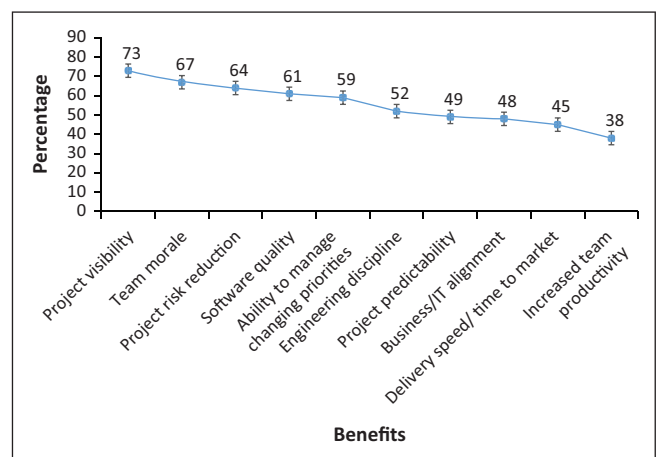

FIGURE 2: Metrics used to measure Agile project success.

FIGURE 3: Reasons for adopting Agile methods.

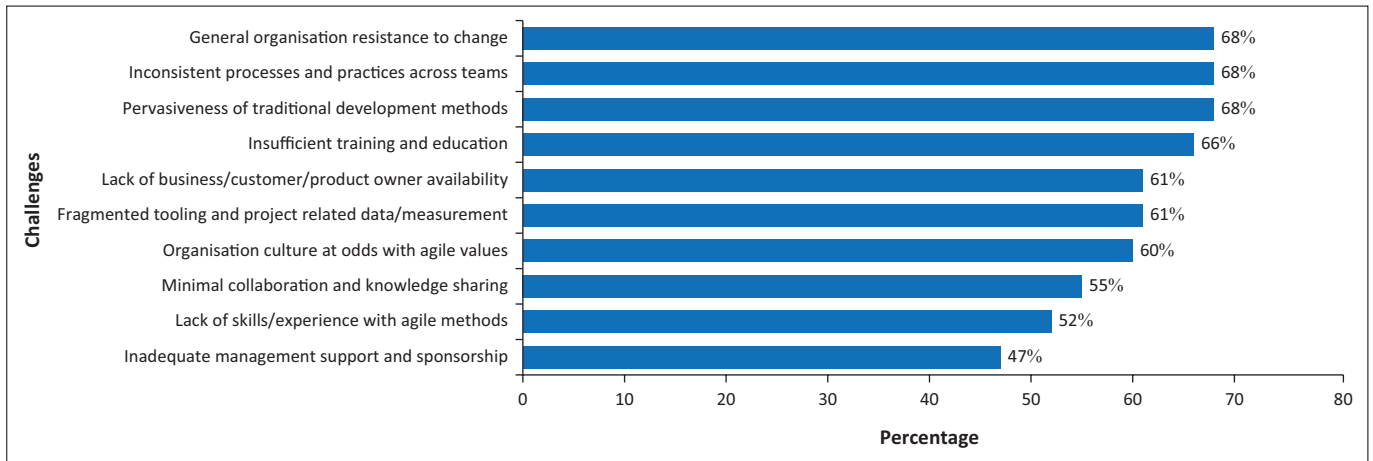**FIGURE 4:** Benefits of adopting Agile methods.

FIGURE 5: Challenges of adopting Agile methods.

Challenges for adopting Agile methods

Although organisations are benefiting from Agile methods, there are also challenges experienced by organisations when adopting Agile methods. In this survey, there was an increase in respondents citing pervasiveness of traditional development methods (68%), inconsistent processes and practices across teams (68%), general organisation resistance to change (68%), insufficient training and education (66%) and fragmented tooling and project related data/measurements (61%) as challenges for adopting Agile methods. Barriers that were cited by VersionOne Inc. (2019) as their top two responses were organisational culture at odds with Agile values and general organisational resistance to change. The results are indicating that organisations are not experiencing new challenges besides the common ones indicated by VersionOne Inc. (2019, 2020) that have been experienced by organisations for the past 2 years. To inculcate the spirit of willingness to change, software developing organisations or teams need to implement a change management strategy. To successfully implement a change management strategy, there is a need for a buy-in at different levels, empowerment and continuity in the event, the experts leave the organisation. Figure 5 shows the challenges of adopting Agile methods.

Conclusion

The data analysis showed that organisations are using a number of metrics to measure Agile software projects beyond the triple constraint. Those metrics include business value, project visibility, process improvement and project scope. As stated by the Agile manifesto, this article has emphasised that customer satisfaction is of utmost importance when developing a software project. Respondents also stated that there are a number of reasons why they are adopting Agile methods. Some of the top reasons included that Agile methods help to better manage distributed teams and increase software maintainability. Benefits and challenges of adopting Agile methods were also identified by participants. Reliability statistics was conducted to highlight if the instrument that was used in the study was reliable and valid, and the scale indicated a degree of internal consistency. Correlation analysis was also conducted to show if there was a relationship between variables and the variables that were tested indicated a weak and moderate positive/negative correlation, which means that there was minimum relationship between variables. Future research should explore and investigate how organisations and employees are adapting to changes that Agile methods brought. On the other angle, future research studies should focus on mapping Agile metrics to specific projects and software developing organisations. Recommendation goes to organisations that are outdated still using waterfall; they should move with time and adopt Agile methods in their software projects because Agile methods have many benefits that help in improving software project success. Software developing organisations should focus on the challenges discussed and offer Agile training and give full support to their project team members, and above all in order to succeed, Agile culture should also be embraced in software developing organisations. It is clear that there are other metrics used to measure Agile success beyond the triple constraint, and organisations are adopting Agile methods for a number of reasons and the benefits that come with adopting Agile. This research article adds to the body of knowledge in two ways: (1) on a practical note, it adds to project manager's knowledge in practice to consider other factors, metrics above the triple constraint, especially when implementing Agile projects, and (2) on a theoretical perspective, this article adds on existing literature on how success should be measured and the metrics to be used to monitor and measure the success of software projects.

Acknowledgements

Funding information

This research received no specific grant from any funding agency in the public, commercial or non-profit sector.

Data availability

Data are the intellectual property of the University of Johannesburg and sharing might be considered if there is a case for it.

Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliated agency of the authors.

References

Bannerman, P.L., 2008, 'Defining project success: A multilevel framework', Proceedings of the Project Management Institute Research Conference, NICTA, Australian Technology Park, Sydney, Australi, pp. 1–14.

Barbalho, S.C.M., Da Silva, G.L. & De Toledo, J.C., 2017, 'The impact analysis of functions of project management office on performance of triple constraint of new-product development projects', *Dirección y Organización* 61, 19–31.

Ben Hachemi, H., 2019, *Application of agile methodology in case company's project management*, viewed 16 March 2020, from https://www.theseus.fi/bitstream/handle/10024/172457/benhachemi_hatim.pdf?sequence=2.

Bergmann, T., 2018, *The relationship between agile project management and project success outcomes*, viewed 23 April 2020, from http://purl.fcla.edu/fcla/etd/CFE0007391.

Bergmann, T. & Karowski, W., 2018, 'Agile project management and project success: A literature review', presented at the international conference on applied human factors and ergonomics, Springer, Orlando, Florida, United States, pp. 405–414.

Biddle, R., Meier, A., Kropp, M. & Anslow, C., 2018, 'Myagile: Sociological and cultural effects of agile on teams and their members', Proceedings of the 11th international workshop on cooperative and human aspects of software engineering, Association for Computing Machinery, Gothenburg, Sweden May 27, 2018, pp. 73–76.

Brezočnik, L., Fister, I. & Podgorelec, V., 2018, 'Scrum task allocation based on particle swarm optimization', presented at the international conference on bioinspired methods and their applications, Springer, Paris, France, May 16–18, pp. 38–49.

Chowdhury, A., 2021, *Agile metrics: The 15 that actually matter for success*, viewed 09 April 2021, from https://www.plutora.com/blog/Agile-metrics.

Creswell, J.W. & Clark, V.L.P., 2018, *Designing and conducting mixed methods research*, Sage, Thousand oaks, CA.

Dikert, K., Paasivaara, M. & Lassenius, C., 2016, 'Challenges and success factors for large-scale agile transformations: A systematic literature review', *Journal of Systems and Software* 119, 87–108. https://doi.org/10.1016/j.jss.2016.06.013

Figalist, I., Elsner, C., Bosch, J. & Olsson, H.H., 2019, 'Scaling agile beyond organizational boundaries: Coordination challenges in software ecosystems', International Conference on Agile Software Development, Springer, Montréal, QC, Canada, May 19, 2019, pp. 189–206.

Field, A., 2018, *Discovering statistics using IBM SPSS statistics*, 5th edn., Cengage Publications , London.

Flora, H.K., 2018, *Adopting an agile approach for the development of mobile applications*, Jaipur.

Forney, S.J., 2019, 'An Agile Success Estimation Framework for Software Projects', PhD dissertation, The George Washington University.

Gandomani, T.J. & Nafchi, M.Z., 2016, 'Agile transition and adoption human-related challenges and issues: A grounded theory approach', *Computers in Human Behavior* 62, 257–266. https://doi.org/10.1016/j.chb.2016.04.009

Hoda, R., Salleh, N. & Grundy, J., 2018, 'The rise and evolution of Agile software development', *IEEE* 35(5), 58–63. https://doi.org/10.1109/MS.2018.290111318

IQBusiness, 2019, *The state of agile in South Africa – 2019*, viewed 09 January 2020, from https://iqbusiness.net/state-Agile-report/.

Knaster, R. & Leffingwell, D., 2018, *SAFe 4.5 distilled: Applying the scaled agile framework for lean enterprises*, Addison-Wesley Professional, Boston, MA.

Khoza, L. & Marnewick, C., 2020, 'Waterfall and agile information system project success rates-A South African perspective', *South African Computer Journal* 32(1), 43–73. https://doi.org/10.18489/sacj.v32i1.683

Kupiainen, E., Mäntylä, M.V. & Itkonen, J., 2015, 'Using metrics in Agile and Lean Software Development–A systematic literature review of industrial studies', *Information and Software Technology* 62, 143–163.

Marnewick, C., 2012, 'A longitudinal analysis of ICT project success', paper presented at the Proceedings of the South African Institute for Computer Scientists and Information Technologists Conference, Association for Computing Machinery, Pretoria, South Africa, October 1–3, 2012, pp. 326–334.

Mirza, M.S. & Datta, S., 2019, 'Strengths and weakness of traditional and Agile processes – A systematic review', *JSW* 14(5), 209–219. https://doi.org/10.17706/jsw.14.5.209-219

Mohamad, A.N., 2018, *The benefit of implementing agile scrum in project management*.

Moura, E.J.D.C., 2018, 'The factors influencing the success of Agile software development projects: A Portuguese perspective', Masters dissertation, Universidade NOVA de Lisboa.

Nazir, N., Hasteer, N. & Majumdar, R., 2019, 'Barriers to agile adoption: A developer perspective', in *System performance and management* analytics, pp. 87–95, Springer, Singapore.

Pallant, J., 2016, *Survival manual: A step by step guide to data analysis using SPSS program*, McGraw-Hill Education, London.

Pirro, L., 2019, *How Agile project management can work for your research*, viewed 16 March 2020, from https://www.nature.com/articles/d41586-019-01184-9.

Ram, P., Rodriguez, P. & Oivo, M., 2018, 'Software process measurement and related challenges in Agile software development: A multiple case study', in *International conference on product-focused software process improvement*, Springer, Wolfsburg, Germany, November 28–30, 2018, pp. 272–287.

Raza, S. & Waheed, U., 2018, 'Managing change in Agile software development a comparative study', presented at the 2018 IEEE 21st International Multi-Topic Conference (INMIC), IEEE, Karachi, Pakistan, November 1– 2, 2018, pp. 1–8.

Saunders, M., Lewis, P. & Thornhill, A., 2019, *Research methods for business students*, 8th edn., Pearson Education Limited, Harlow.

Scaled Agile Inc., 2019, *Achieving business agility with Safe 5.0*, viewed 23 July 2020, from https://www.scaledagile.com/resources/safe-whitepaper/.

Sjøberg, D.I., 2018, 'Teamwork quality and team performance: Exploring differences between small and large agile projects', Proceedings of the 19th International Conference on Agile Processes in Software Engineering and Extreme Programming, Springer, Porto, Portugal, pp 267–274.

Stephanie, G., 2018, *Cronbach's alpha: Simple definition, use and interpretation*, viewed 18 August 2019, from https://www.statisticshowto.datasciencecentral.com/cronbachs-alpha-spss/.

Taber, K.S., 2018, 'The use of Cronbach's alpha when developing and reporting research instruments in science education', *Research in Science Education* 48(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2

Thompson, K., 2019, *The Agile PMO*, Site Projectmanagement.Com, viewed 28 August 2018, from http://www.Projectmanagement.Com/Pdf/TheAgilePMO.Pdf.

Thomsen, L.K., Lausten, T., Rasmussen, M. & Jensen, C.L., 2019, 'Collaborative peer-peer project, an attempt to improve biomedical students skills in knowledge acquisition collaboration and project management', presented at the NML conference 2019, viewed 23 April 2020, from https://ibl-inst.se/nml-conference-2019/.

Tripp, J., Saltz, J. & Turk, D., 2018, 'Thoughts on current and future research on agile and lean: Ensuring relevance and rigor', Proceedings of the 51st Hawaii international conference on system sciences, viewed 19 May 2020, from http://hdl.handle.net/10125/50570.10.24251/HICSS.2018.681.

Turner, J.R. & Xue, Y., 2018, 'On the success of megaprojects', *International Journal of Managing Projects in Business* 11(3), 783–805. https://doi.org/10.1108/IJMPB-06-2017-0062

VersionOne Inc., 2019, *The 13th annual state of agile report*, viewed 18 October 2020, from https://www.stateofagile.com/#ufh-i-521251909-13th-annual-state-of-Agile-report/473508.

VersionOne Inc., 2020, *The 14th annual state of agile report*, viewed 29 August 2020, from https://stateofagile.com/#ufh-i-615706098-14th-annual-state-of-Agile-report/7027494.

Zohner, C.M., Rockinger, A. & Renner, S.S., 2019, 'Increased autumn productivity permits temperate trees to compensate for spring frost damage', *New Phytologist* 221(2), 789–795. https://doi.org/10.1111/nph.15445