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RESEARCH PAPER

An Empirical Study on Impact of Project Management Constraints in Agile Software Development: Multigroup Analysis between Scrum and Kanban

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ABSTRACT

Goal: The Study aims to investigate the impact of project management constraints in fixed-cost and fixed-scheduled Agile software development contracts using multigroup analysis (MGA) to perform repeated comparisons of parameters across groups of Scrum or Kanban methodologies using structural equation modelling (SEM)

Design/Methodology/Approach: A web-based survey is used to collect responses to a questionnaire based on project management constraints for Kanban and Scrum method-based Agile software development projects from people working on projects fixed-cost and fixed-schedule contracts and then analyzed with the help of multi-group analysis using SmartPLS 4.0

Results: Risk management has a mediating effect between project scope, resources, and delivery quality. MGA implied that the Kanban method is better at managing resources and will have a higher impact on the quality of deliverables than the Scrum method.

Limitations of the investigation: Evaluating the suitability of various multi-group analysis approaches requires more than just our empirical example using satisfactory data and other project management constraints.

Practical implications: The findings of the study suggest that hypothesis testing should be carried out for a distinct model parameter between study groups, whenever they are comparing more than two group.

Originality/Value: This study helps in contributing to exploring PLS route modelling by the introduction of the original non-parametric confidence set approach based on a comparison of parameter estimations and bootstrap confidence intervals. The study investigates the impact of several project management constraints on to fixed-cost Agile software development projects.

Keywords: Scrum; Agile Software Development; Theory of Constraints (TOC); Multi-group Analysis; Structural Equation Modelling.

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1. INTRODUCTION

As a realistic and adaptable approach to project management methods, Agile has been widely employed in several business sectors. In the era of rapid transformation, Agile development is known for dealing with complex issues and rapidly adapting to business changes by collaborating with customers Agile project management is thought to be able to address this issue given project management demands a more flexible and dynamic approach. The scope of the project would directly affect project timelines and budgets. (Zanezi; Carvalho, 2022) Though Agile is known for its fast response to change, uncontrollable changes would cause delays and would incur costs. The Agile movement began in 2001 as a response to the Waterfall software development life cycle (SDLC) flaws. (Beck et al., 2001) Scrum is one of the approaches used by the Agile methodology and is based on lean manufacturing principles. (Oliveira et al.,2023) Kanban is a distinct approach built on the Agile movement that was influenced by both Lean manufacturing and the Toyota Production System. Organizations have recently started using the Kanban and Scrum techniques as effective tools for software development. Although there has been discussion on which of these strategies is preferable for a long time, there hasn't been enough statistical analysis-based data to make a decision. The study's primary objective is to investigate if Scrum and Kanban methods differ in impacting several aspects of software development project management. (Lei et al., 2017) The Star Model of project management is built based on the Project management body of knowledge. (Atencio; Bustos, 2022) This study primarily focuses on other project management factors because Agile development projects are strictly time-bounded and distinguished by managing costs effectively. These factors include the scope of the project, cost, schedule, risk assessment, quality of the deliverables, and effective use of resources.

This study addresses the gap in the current literature as it empirically explores an impact of constraints in Agile projects having discrete methodologies of execution but with fixed cost contracts. These Agile project management constraints include an uncertain scope, effective resource management and proactive risk management. Different Agile frameworks, like Scrum and Kanban, offer various methods for handling risks. (Nurdiani et al., 2016) In Agile projects, there is a trade-off between risk management and product quality, but the impact of these factors as project management constraints, is not being empirically investigated in previous studies, which is carried out during this study as an original contribution to the body of knowledge.

2. LITERATURE REVIEW

The Project Management Body of Knowledge (PMBOK) is created by the Project Management Institute (PMI) and gives a knowledge base and project management framework about project management. PMBOK, the most extensively used project management framework concept, was evaluated in the literature by the writers. (Imran; Soomro, 2022) Before Agile software development, several methodologies were employed for software development. These techniques were used to identify more effective ways to specify the project's needs, analyse the issue, and implement it methodically. Agile project management methods were developed to handle projects with rapidly changing project scopes, delivery schedules, and budgets. The Manifesto for Agile Software Development, which outlines the structure and objectives of these approaches, was released. (Anderson et al., 2012) The Scrum methodology of software development is characterized as- it is an incremental and iterative project management methodology designed for risk reduction with predictable project execution of the project. (Oliveira et al.,2023) It is founded on the notion of empirical process control., Scrum employs time-boxed events during project planning and execution. Scrum events are made to examine artifacts and adopt fresh approaches to challenges facing the project. These activities are intended to promote the development process' transparency, adaptability, and inspection. (Alqudah; Razali, 2017) Kanban is the just-in-time delivery method in software development project management. The kanban method focused the on work to be done and its timelines. It achieves this by setting task priorities, outlining the procedure, and specifying the lead time for delivery.

(Ozkan et al., 2022) The Kanban is flexible as it focuses on the project's important tasks and prioritizes them. (Marnada et al., 2022) According to Kniberg and Skarin, Scrum and Kanban are alike as" they are both Lean and capacity to divide work into smaller pieces, have self-organized teams, concentrate on delivering usable software frequently, adjust to changes quickly, limit Work in Progress (WIP), use pull-scheduling, and use transparency. (Kniberg; Skarin, 2010) Keogh further emphasizes that both strategies outperform the Waterfall technique in terms of efficiency. They also provide a thorough outline of the project's scope and tools for improvement. They also place a priority on meeting deliverables and the value of the project. (Keogh, 2011)

Fundamentally Kanban and Scrum differ in mode of execution, requirements of work iterations, methods adopted to work assignments to cross-functional team members, whether WIP is limited, and work distributions are done in specific time-bounded frames. (Mamanovna; Ligay, 2023) Kniberg's paper provides a detailed explanation of the key observation-based distinctions between Scrum and Kanban. There are differences, such as whether time-boxed iterations are required, whether a team commits to a specific amount of work for a given product iteration, whether cross-functional teams are required, whether WIP is limited, and whether work needs to be divided up to be completed within a specific time frame and it illustrates the many contexts in which Scrum or Kanban are effective. (Kniberg; Skarin, 2010).

3. THEORETICAL BACKGROUND

The Theory of Constraints (ToC) in Project Management is a method for identifying the critical limiting factor, often known as a constraint or bottleneck, that stands in the way of attaining a goal. Eliyahu M. Goldratt, an Israeli businessman, invented the Theory of Constraints (TOC). The key assumption is that any system will always have at least one component that will limit or slow down processes. According to the theory of constraints, each complex system consists of numerous connected activities, where one of them, the weak link in the chain, can disrupt the entire system. The theory states that the best method for a company to achieve its goals is to minimize operational expenditures and inventory along with boosting quality throughput. According to TOC, there would be at least one constraint that would affect the execution of the project. There are three project management constraints i.e., Timelines, costs, and Scope, which determine the success or failure of each project getting executed (Goldratt, 1990; Elmezain et al., 2021)

Previously, the performance of traditionally generated software projects was evaluated using the triple constraint of cost, scope, and time. These three limitations, however, are no longer helpful in assessing the performance of Agile software projects. As fixed cost contracts are not suitable for Agile software development projects due to their characteristics of accepting changes, cost as constraints have been eliminated from the constraints, and Resource related constraints are considered as the Agile method of software development methods are highly focused on people working within the development teams. (Van et al., 2012)

4. CONCEPTUALIZATION OF STUDY CONSTRUCTS

Scope management is a salient characteristic of long-duration projects as it limits the changes in the Software development life cycle (SDLC). It estimates schedule, work size, and cost for entire projects. A well-defined project scope will significantly impact the quality of project deliverables. (Al-Rubaiei et al.,2018; Thakurta, 2013)

H1: The quality of the project deliverables is significantly impacted by the Agile software development project scope. (Al-Rubaiei et al.,2018; Thakurta, 2013)

The scope of a project will nearly always alter at some point throughout its existence. This may be addressed with appropriate planning and knowledge of project risk so that the project is not derailed. Scope risks are unforeseeable occurrences or situations relating to the project's scope. A well-defined project scope will reduce the risks to the project and vice versa. (Alves et al., 2021) The risk includes scope changes due to the following factors: Scope

creep occurs when clients add to the project's requirements, issues with code integration, and dependencies change. (Sirshar; Khalid, 2019; Wideman, 2022)

H2: The Project risks will be significantly impacted by the scope of the Agile software development projects. (Sirshar; Khalid, 2019; Wideman, 2022)

The resource risks are the risks related to resources that restrict them from achieving committed work in the project. Many a time these risks arise from the uncontrollable elements of a project manager. (Bannerman, 2008; Chowdhury ; Arefeen, 2011; McManus, 2012)

H3: The Agile software development project resources will significantly impact risks in these projects. (Bannerman, 2008; Chowdhury; Arefeen, 2011; McManus, 2012)

ASQ provides resources, knowledge, and tools for quality management and improvement in a wide range of resources and sectors. The availability of skilled resources and adequate tools and infrastructure will ensure the improved quality of the project output. (Sudhakar et al., 2011; Lalsing et al., 2012; Dingsøyr et al.,2016) hence we have formulated the following hypothesis-

H4: Project resources will significantly impact the quality of the project deliverables. (Sudhakar et al., 2011; Lalsing et al., 2012; Dingsøyr et al.,2016)

Quality of outputs is frequently seen as a subjective assessment of how well a certain output will perform. Because the quality of inputs influences the quality of the project, project managers must evaluate the impact

of risk management. A comprehensive risk management strategy will aid in ensuring quality; (Albadarneh et al., 2015; Buganová; Šimíčková, 2019) hence the following hypothesis is formulated-

H5: Risk management will significantly impact the quality of the project deliverables. (Boehm, 1991; Albadarneh et al., 2015; Buganová; Šimíčková, 2019)

Risk management helps enterprises comply with regulations while enterprises comply with regulations while also having a superior decision-making framework. Risk management outcomes enable firms to anticipate strategy efficiency and efficacy improvements outcomes of risk management enable firms to anticipate improvements in strategy efficiency and efficacy. Furthermore, the quality of deliverables is effectively maintained. (Albadarneh et al., 2015; Chowdhury; Arefeen, 2011; Buganová;Šimíčková, 2019) hence have proposed the following hypothesis-

H6: Risk management in projects is mediating between project scope and resources, through achieving the quality of the project deliverables. (Albadarneh et al., 2015; Chowdhury; Arefeen, 2011; Buganová; Šimíčková, 2019)

The following table shows the study variables for respective constraints-

Table 1- Study Variables

Latent Constructs	Indicators	Reference
Quality of Deliverables	Improved the code Quality (QT1)	(Pai et al., 2021; Noor et al., 2014)
	Predictability (QT2)	(Trendowicz, 2013; Haindl ; Plösch, 2022)
	Customer Satisfaction (QT3)	(Baquero, 2022; Salin et al., 2022)
Resources	Availability of Resources (RS1)	(Powell; Jandreau, 2022; Kerzner, 2022)
	Competency and Skills of Resources (RS2)	(Kassab, 2014; Kerzner, 2022)
	Tools & Infrastructure Available (RS3)	(Özkan; Mishra, 2019)
Risk Management	Proactive Planning for Risks (RK1)	(Hijazi et al., 2012; Ghane, 2017; Riaz; Gilani, 2022)
	Effective Risk Mitigation (RK2)	(Hijazi et al., 2012; Ghane, 2017; Riaz; Gilani, 2022)
	Effective Risk Governance (RK3)	(Hijazi et al., 2012; Ghane, 2017; Riaz; Gilani, 2022)
Scope of the project	Backlog Grooming/Prioritisation (SC1)	(Hayat et al., 2019; Gheorghe et al., 2020; Aizaz et al., 2021)
	Limiting the Work Backlog (SC2)	(Hayat et al., 2019; Gheorghe et al., 2020; Aizaz et al., 2021)
	Limiting the requirement changes (SC3)	(Hayat et al., 2019; Gheorghe et al., 2020; Aizaz et al., 2021)

Source: The authors themselves.

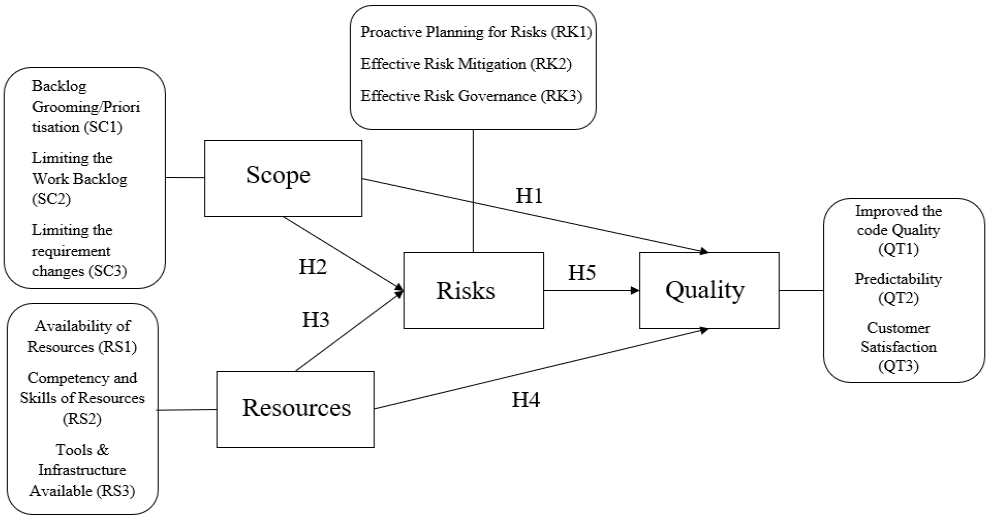

Figure 1 - Proposed research model for project management constraints

5. RESEARCH METHODOLOGY

The objective of this study is to investigate how Kanban and Scrum methodologies of Agile software development, differ from each other with the help of statistical analysis, based on the experience of Agile practitioners. This study focuses on project management constraints like- resources, projects' scope, and risks, excluding other constraints of the Start model of project management such as schedule and costs as here we are focusing on the fixed-cost and fixed-schedule Agile software development projects. In this study, the scope factor represents the goals and demands of the project, while the schedule deals with the timelines of project deliveries. The quality constraint is concerned with the project's overall performance, whereas the Resources constraint is focused on all types of project resources-constraints related to human and material resources. The Risk management constraint deals with the effectiveness of project execution while dealing with several associated with project risks. This study is intended to statistically compare, the effectiveness of Kanban and Scrum methods of Agile software development projects which are being executed with fixed-cost and fixed-schedule contracts.

5.1 Research design

We have used a survey instrument using Google forms to gather responses to questions related to project management constraints concerning the proposed research model for both- Kanban and Scrum method-based Agile software development projects. The targeted study sample was the respondents from software development teams working on Scrum or Kanban methodologies and working on projects those are with fixed-cost and fixed-schedule contracts. All the responses were collected from August to November 2022. All of the project management constraints were addressed in the survey questions. Each survey question was followed by one of the following replies from the five-pointer Likert Scale and all the responses are collected from the options based on the scale- Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree. A numerical score is given to each response on the Likert scale, and this score is used to quantify data for the survey response. Two subsets/subgroups of the survey data were created: (a) Projects using the Scrum method and (b) Projects using the Kanban method. Out of 102 respondents., 38% (39 respondents) were using the Kanban method, whereas 62% (63 respondents) used the Scrum method.

5.2 Research setting

The participants in this research are members of software development teams, with a particular on Pune-area software development companies. This is the population of the research. These companies have a substantial employee base and have been in the software development industry for many years. These companies are all using Agile software development methodologies more and more. Kanban and Scrum-based software development projects serve as the study's example frame. To gather sample data, we have been in touch with ten organizations.

5.3 Sampling

We have used Cochran's sampling formula to calculate the optimized sample size for an unknown population. (Cochran, 1977) As a result of our collaboration with these software development companies, we calculated that there are more than 10,000 Agile software development teams in existence. The marginal error (e), with 95% confidence intervals, was estimated to be 10%. The sample frame for this study consisted of software engineers with a minimum of one year of experience in agile software development. As the derived sample size is 100, in this study we have considered 102 respondents as the optimum size of the sample, out of the 350 people who were questioned. Regardless of their employment positions or cumulative years of experience, this research includes all team members who work in Agile software development teams utilizing Scrum or Kanban methodology.

$$\mathrm{n} = (z\text{^}2\ P(1-P))/\mathrm{e}\text{^}2 \quad (1)$$

here, n = sample size, z = critical value for % confidence level, e = margin of error, and p = the sample proportion. Due to time and money restrictions, and because this was pilot research, we drew a smaller sample in this case.

Table 2 - Sample size Calculation

Particulars	Values
Population Size (N)	>10000
Z Value (for 98% confidence interval)	1.96
Population Proportion (p)	0.5
The Margin of Error (e)	0.1
Sample Size (n)	100

Source: Cochran (1977).

As we intended to collect data from subject matter experts, working in specific area of Agile project management we have used convenient sample. In addition to the above calculations, as this study uses PLS-SEM methodology for analysis, we determine the optimum sample size for a structural equation model (SEM) with the help of a-priori analysis using Cohen's Structural Equation Model (SEM) lower bound sample size formula:

$$\mathrm{n= max\ (n1, n2)}$$

$$\mathrm{n1= \left[50\left(\frac{j}{k}\right)\text{^}2 - 450\ \left(\frac{j}{k}\right) + 1100\right]}$$

$$\mathrm{n2 = \left[\frac{1}{H}\ \left(A(\frac{\pi}{6} - B + D\right) + H\sqrt{\left(A\left((\frac{\pi}{6} - B + D\right) + H\right)\text{^}2 + 4AH(\frac{\pi}{6} + \sqrt{A} + 2B - C - 2D)}\right]}$$

$$\mathrm{A = (1\text{-}p2),\ B= parcsin\ (p/2),\ C = parcsin\ (p)}$$

$$\mathrm{D= A/\sqrt{(3-A)}\ ,\ H= \left(\frac{\delta}{z1-\alpha/2-z1-\beta}\right)\ \text{^}\ 2} \quad (2)$$

Note(S): Where n= sample size, j = number of observed variables, k = the number of latent variables, ρ =the estimated Gini correlation for a bivariate normal random vector, δ = the anticipated effect size, α is the Sidak-corrected Type I error rate, β = the Type II error rate, and z = a standard normal score.

Source: Cohen (1988).

For the proposed study model, we have the Latent Constructs =3 and Observed Variables = 12. For Expected Effect Size (d) = 0.5 and Statistical Power = 0.8 with p-value = 0.05, calculated value for minimum and recommended sample size for model structure = 100 and minimum sample size to detect effect = 30. As both formulas give the optimum size of the sample =100, hence the sample size for the study = 102 is justified.

5.4 Survey design

This poll was divided into two sections: (1) We developed a simple questionnaire to collect the demographic data of participants along with the type of Agile software development method that they are using, (2) This section intended for the collection of variables associated with determining project management constraints. We employed Google Forms to implement the survey for this study. Email notifications and social media channels were used to distribute survey links. Additionally, we informed each participant and, via a checkbox included at the start of the survey, we got their consent to utilize their data. For this study, we have used convenience sampling. The study survey was carried out between July to November of 2022.

5.5 Procedure for data analysis

We performed, a Confirmatory Component Analysis (CCA), followed by a carried out for hypothesis testing, to identify intra-variable correlations. Data reliability was assessed using Composite Dependability (CR) and Cronbach's coefficient of reliability. According to Hair et al., we accept values larger than the reference value of 0.7 since doing so helps establish the internal consistency of the data, which is necessary for excellent findings.

6. DATA ANALYSIS

6.1 Sample profile

In this sample, of the 100 responders in this sample, 63 used the Scrum technique for their development projects, while the remaining 38 used Kanban. Among all responders, 32 women and 68 men made up the sample. Out of all participants, 46 were between the ages of 21 and 30; 42 were between the ages of 31 and 40; and just 13 were above the age of 40. Out of all respondents, 56 were allocated to managerial roles while 32 of them were part of software development teams. The remaining 12 respondents played their respective roles in these development projects' enabling and supporting functions. If we consider the total year of experience of respondents, 48 participants had an experience of fewer than five years, 27 had an experience of five to ten years, 24 had an experience of ten to fifteen years, and just two of all respondents had an experience of more than fifteen years.

6.2 Reliability and validity

We conducted Cronbach's Alpha and Composite Reliability tests to make sure the data gathered was reliable (CR). At first, variables with loadings greater than 0.7 were selected, and all variables with low loadings (0.06) were excluded. After examining the data validity, we do a confirmatory Component Analysis (CCA) with the help of partial least squares (PLS) algorithm to examine the relationship between the study's observable variables and the associated latent variables. Convergent Validity was indicated by the loading value 0.7 with Average Variance Extracted (AVE). To gauge discriminant validity, cross-loadings were applied. The discriminant validity is supported by the fact that all the cross-loadings are less than the factor loadings.

Table 3 - Reliability and Validity Statistics

latent Constructs	Cronbach's Alpha (α)	Composite Reliability (rho a)	Composite Reliability (rho c)	The Avg. Variance Extracted (AVE)
Quality of Deliverables	0.723	0.744	0.842	0.641
Resources	0.771	0.776	0.867	0.685
Risk Management	0.729	0.748	0.847	0.649
Scope of Project	0.761	0.776	0.862	0.677

Source: The authors themselves.

6.3 Confirmatory component analysis (CCA)

We conducted a CCA, validated the study hypotheses, and assessed the validity of the proposed research model. The diagonal values in the CCA table relate to convergent validity when the loading is higher than 0.7. Lower scores reflect the discriminative validity of the components, which are represented by the values outside the diagonal. There were originally 31 questions on the form. Following the application of the CCA, we discovered four constructs and twelve components with significant relationships.

Table 4 - Confirmatory Component Analysis

Variables	Quality of Deliverables	Resources	Risk Management	Scope of the project
Improved the code Quality (QT1)	0.85			
Predictability (QT2)	0.816			
Customer Satisfaction (QT3)	0.731			
Availability of Resources (RS1)		0.868		
Competency and Skills of Resources (RS2)		0.803		
Tools & Infrastructure Available (RS3)		0.81		
Proactive Planning for Risks (RK1)			0.742	
Effective Risk Mitigation (RK2)			0.801	
Effective Risk Governance (RK3)			0.869	
Backlog Grooming/Prioritisation (SC1)				0.884
Limiting the Work Backlog (SC2)				0.808
Limiting the requirement changes (SC3)				0.772

Source: The authors themselves.

6.4 Measurement model

When evaluating the validity and reliability of constructs, the partial least square (PSL) algorithm is employed to solve fixed point equations using the weight vectors gained upon convergence. The measurement model is assessed using the factor weighing approach, with a maximum iteration of 300 and a stop threshold (10X) of 7. Convergent validity (factor loadings are greater than 0.5) is thought to be established. The applied statements for each model construct are shown in the table below, with respective loadings, CR, Cronbach's alpha value, and AVE. According to Hair, we have eliminated the lower factor loading values and cross-loadings from the statements (Hair, 2010) Cronbach Alpha values for each construct are near to or equal to the above-mentioned value of 0. 7. These findings show that the elements in the measuring instrument are reliable. The below table shows the discriminant validity. It suggests that the model's squared correlations with all other constructs should be smaller than the AVE for all the latent constructs. Since there is little chance of multi-

collinearity in this model, the correlations within the factors are substantial (< 0.80) (Tabachnick, 2007; Grewal et al., 2004). This model has convergent validity established for all constructs and hence is consistent. For all constructs, Cronbach's reliability coefficient is > 0.7 and AVE values are > 0.5, and there are substantial factor loadings (for all >0.8). This establishes the discriminant validity since each row and column's main diagonal has the biggest absolute value. (Bagozziand Yi, 1988; Falk; Miller, 1992). The proposed model is a good fit for the aforementioned conditions.

6.5 Structural Model

The projected structural model is built and tested using SmartPLS's Bootstrapping approach once construct and item reliability and validity have been established. This will make it easier to comprehend the inter-relativity among these variables. Here we have used, path coefficients, t-values, and R-square values to assess the model's fitness. The dependent variable should have a considerable influence if the threshold is at least 10%. (Falk; Miller, 1992).The percentage variation caused by changes in the independent factors for dependent variables was addressed by the coefficient of determination (R squared). The recommended model has strong explanatory and predictive ability since the R2 value is larger than 0.1 and the Q2 value is greater than zero. It helped us determine whether the route model was still relevant. Our sample size for bootstrapping was 5000. To enhance sampling, we have used a biased adjusted two-tailed test with a significance level of 0.05. We employed a partial least square with a path weighting approach with 700 iterations to look at the effects of the inter-variate variables. For the model, we compute the Path coefficient.

Table 5 - Structural Model

Constructs	Variables	Indicator	Factor Loading
Quality of Deliverables (Quality) (α =0.723, CR= 0.744)	Improved the code quality	QT1	0.85
	Predictability	QT2	0.816
	Customer Satisfaction	QT3	0.731
Resources (Resources) (α =0.771, CR= 0.776)	Availability of Resources	RS1	0.868
	Competency and Skills of Resources	RS2	0.803
	Tools and Infrastructure Available	RS3	0.81
Risk Management (Risk) (α =0.729, CR= 0.748)	Proactive Planning for Risks	RK1	0.742
	Effective Risk Mitigation	RK2	0.801
	Effective Risk Governance	RK3	0.869
Scope of the project (Scope) (α =0.761, CR= 0.776)	Backlog Grooming/Prioritisation	SC1	0.884
	Limiting the Work Backlog	SC2	0.808
	Limiting the requirement changes	SC3	0.772

Note (s): Sample population (n) = 102, Cronbach's reliability coefficient (α) ≥ 0.7 which is recommended, Construct Reliability (CR) , for all constructs CR > 0.8 which is recommended
Source: The authors themselves.

6.6 Discriminant validity

The discriminatory validity is established by relevant correlation values for these constructs in the table are less than the SQRT(AVE) diagonal values. All of the constructions are distinct from one another. The measurement model is constructed of each set of relationships between a latent construct and real measurement items, which are utilized to determine the value of each latent construct. In this case, we're utilizing a reflective model in which the objects represent their respective latent constructs.

Table 6 - Discriminant Validity

Constructs	Quality	Resources	Risk	Scope
Quality	0.801			
Resources	0.394	0.827		
Risk	0.584	0.732	0.806	
Scope	0.541	0.797	0.729	0.823

Note (S): Utilizing the Fornell-Larcker criteria for discriminant validity. Since the diagonal values for SQRT(AVE) values in the preceding table are less than the relevant correlation values for these constructs, discriminating validity is maintained. The creations all differ from one another.
Source: The authors themselves.

6.7 Mediation analysis

Employing mediation analysis, one might look at the mechanism behind a relationship between the two variables. The question of how variables are related is addressed by this approach. The relationship between an independent and a dependent variable is explained by a mediator variable. To estimate a population parameter, bootstrapping utilizes random resampling with replacement. To ascertain if a mediating variable can adequately account for the influence of an independent variable on a dependent variable, mediation studies are carried out.

Table7 - Results predictive relevance for R2 and Q2

Independent constructs	R-square	Q-Square
Quality	0.4	0.384
Risk	0.594	0.587

Source: The authors themselves.

Table 8 - Path Coefficients

Path Posited	Original sample (β)	Sample Mean (X)	S.D. (σ)	T statistics (|O/STDEV|)	P values
Resources -> Quality	-0.312	-0.313	0.155	2.009	0.022
Resources -> Risk	0.413	0.41	0.105	3.93	0.000
Risk -> Quality	0.505	0.511	0.099	5.103	0.000
Scope -> Quality	0.421	0.422	0.157	2.673	0.004
Scope -> Risk	0.4	0.407	0.104	3.845	0.000

Note(S): At a 1% level of significance, all of the factor loadings are significant, and all of the pathways are significant.
Source: The authors themselves.

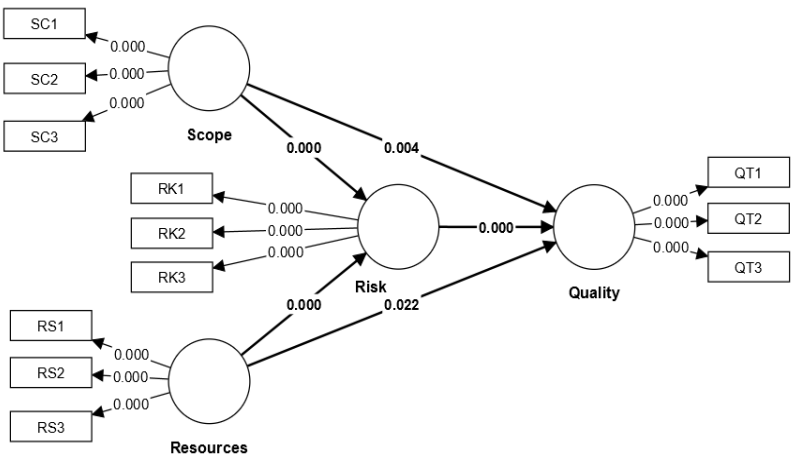

Figure 2 - Measurement Model

Table 9 - Mediation Analysis

Hypothesis	Total Effect		Indirect Effects		Decision Bootstrapping with a 95% Confidence Interval
	Original sample (β)	T Values	Estimate	Lower	Upper
Resources -> Quality	-0.103	0.657			
Scope -> Quality	0.623	4.211			
Resources -> Risk -> Quality			3.319	0.120	0.332
Scope -> Risk -> Quality			2.797	0.097	0.328

Note (s): As total and indirect effects are significant for paths between the following constructs, Resources to Quality and Scope to Quality, the Risk construct has full mediation effects among these latent constructs
Source: The authors themselves.

6.8 Multigroup analysis

The information gathered indicates project management constraints, using Scrum and Kanban methods for software development. A Multigroup Analysis (MGA) was done on acquired data to understand specific characteristics of several methods of Agile software development methods. Before performing the MGA, the conceptual model must demonstrate measurement invariance sufficiency using the measurement invariance of composites (MICOM) approach. MICOM is required for comparing the MGA's group-specific variances of PLS-SEM results (Henseler et al., 2016; Leguina, 2015). MICOM is a two-step technique that includes configurable and compositional invariance.

Table 10 - Measurement Invariance of Composite (MICOM)

x	Configural Invariance		Compositional Invariance
	Original correlation	Correlation permutation means	Permutation p-value
Quality	0.989	0.993	0.198
Resources	0.996	0.997	0.243
Risk	1	0.996	0.972
Scope	0.997	0.996	0.391

Source: The authors themselves.

All ten constructs are consistent with configurable and compositional invariance in the table above. It depicts that Agile project management constraints moderate all designed constructs. Hence, in compliance with the MICOM results displayed in the table above, here we investigated the measurement invariance between two groups – 1. Scrum and 2. Kanban. Further, the study employs multigroup analysis to test the moderating effect of Agile project constraints on individual hypotheses designed for the conceptual model.

Table 11- Multi-Group Analysis Results

Path	Hypothesis	Original (Scrum)	p-value (Scrum)	Original (Kanban)	p-value (Kanban)	Measurement Invariant
Scope -> Quality	H1	0.548	0.608	0.023	0	Yes
Scope -> Risk	H2	0.475	0.235	0	0.069	No
Resources -> Quality	H3	-0.122	-0.066	0.325	0.372	No
Resources -> Risk	H4	0.279	0.602	0.027	0	Yes
Risk -> Quality	H5	0.582	0.379	0	0.033	Yes

Note(s): Significant at 0.05, Results for Henseler (2007) eligible for a one-sided test.
Source: The authors themselves.

Table 12 - Total and Specific Indirect effects of MGA

Path	Original (Scrum)	p-value (Scrum)	Original (Kanban)	p-value (Kanban)	Measurement Invariant
Resources -> Quality	0.162	0.228	0.045	0.048	Yes
Scope -> Quality	0.277	0.089	0.008	0.144	No
Resources -> Risk -> Quality	0.162	0.228	0.045	0.047	Yes
Scope -> Risk -> Quality	0.277	0.089	0.007	0.142	No

Note(s): Results of the Multigroup Comparison and Bias-corrected 95% Confidence Intervals (Shi, 1992)
Source: The authors themselves.

The MGA results of a nonparametric method, Henseler's bootstrapping-based MGA, are displayed in the table above (Henseler et al., 2009). Henseler's MGA results and the permutation approach revealed important distinctions between Scrum and Kanban. Specifically, Henseler's MGA with a p-value < 0.05 and the Permutation test with a p-value < 0.1, suggested that there was a significant difference between Scrum and Kanban. (Hair et al., 2018). Further in the study, the results show a considerable dissimilarity between Scope to Quality, Resources to Risk, and Risk to Quality (H1, H4, and H5) at a p-value < 0.05 and the permutation test value < 0.1(Hair et al., 2018). When indirect effects are concerned, it shows inferred that there is a management invariant from Resources to Quality through Risk management constraint, but insignificant for the scope constraint.

Risk management is essential to the Agile project management methodology because it mediates the conflict between the scope and quality of the deliverables. Agile teams can keep the project on schedule, achieve its goals, and maintain the intended level of quality by proactively addressing risks and it plays a mediating role within Agile project management to ensure that scope and quality are maintained throughout the project lifetime, which is essential to ensuring that resources are used efficiently.

While discussing the effectiveness of resources implementing Kanban and Scrum methodology, with respect to risk management, even though there is hardly any difference. The results of the study shows that the resources implementing the Kanban methodology are better in risks management and will have improved quality of deliverables. Probably it is because, Kanban methodology emphases on visualizing and optimizing the work flow and managing risks via an ongoing feedback loop. Kanban may assist to identify possible hazards earlier in the project lifecycle and establish mitigation techniques to address them by reducing the amount of work in progress and improving the flow of work. Kanban boards' visual nature also makes it simpler to spot and fix workflow bottlenecks, which can assist to reduce risks and guarantee that the project execution continues.

7. IMPLICATIONS

The study's findings suggest that hypothesis testing should be carried out for a distinct model parameter between study groups, whenever they are comparing more than two groups (in this example, Scrum and Kanban). Researchers should next use the cutting-edge confidence set technique to multi-group analysis to compare two groups of data whether this hypothesis is confirmed or if there are just two groups. Evaluating the suitability of various multi-group analysis approaches requires more than just our empirical example using satisfactory data.

8. LIMITATIONS AND FUTURE RESEARCH

In most of the previous studies on PLS route modelling while performing the multi-group analysis (MGA), calculating measurement invariance was not considered a requirement while calculating reliability and validity. Haenlein and Kaplan (2011) offered a strategy when the construct's domain differs between groups, suggesting combining the Box's M test with ordinary least squares regressions to assess the magnitude of this bias and let researchers

decide whether to accept parameter values or not. (Haenlein; Kaplan, 2011) In contrast, Rigdon et al. argue that "an insistence on measurement invariance across groups carries its assumption that the effect of group membership is constrained to the structural parameters of the structural model" in their discussion of measurement invariance in PLS path modelling. (Rigdon et al.; 2010) The consequences of group inclusion on measurement and structural features should be investigated by researchers because this assumption is often incorrect, if not absurd. The authors also note that PLS route modelling is an approximation-based method created for situations with a less clear theoretical background (Wold, 1982). Therefore, while evaluating the results of PLS route modelling combining several groups, researchers should be used.

9. ORIGINALITY

PLS path modelling is a crucial multivariate analytic strategy in empirical research (Henseler et al., 2009), and MGA is particularly significant in this area of study. The following ways that this work advances our understanding of PLS route modelling: First, we go through and contrast the various PLS route modelling multigroup analysis approaches. This is followed by the introduction of the original non-parametric confidence set approach based on a comparison of parameter estimations and bootstrap confidence intervals. Then, we address the problem of simultaneously comparing more than two groups by presenting a permutation-based analysis of variance method that compares the Scrum and Kanban approaches to Agile software development, does not rely on distributional assumptions, and demonstrates a suitable level of statistical power.

10. CONCLUSION

This study attempts to dive deeper into the fact of the operational capabilities of Agile software development methodologies, which the authors corroborate with the aid of various prior studies. Indeed, a strong understanding of software engineering, with a focus on Agile software development, is essential for success. Thus, the purpose of this study is to determine whether there is a difference in perception between the Scrum and Kanban methodologies groups. The first portion of the research shows that risk management has a mediating influence between project scope, resources, and delivery quality. This indicates that thorough risk management will aid in the improvement of delivery quality and hence it is vital to establish control over risks and manage them rigorously.

The theoretical implications of the study is that, it can be beneficial in detecting, evaluating, and managing risks in Agile software development projects. Agile project management places a strong emphasis on teamwork and communication. This is especially useful for managing risks since it enables a common knowledge of problems and potential solutions. Continuous risks assessment would help to ensure early identification of issues and improving quality of the deliverables. In in context of Practical implications, Agile teams can take immediate measures to limit risks and lessen their influence on the quality of the deliverables by continuously identifying them early in the project lifecycle. The risk management processes can be integrated with scope and resource management for better decision-making mechanism and have control over these risks by the collaborative approach as a vital requirement of Agile project development process.

Further in the discourse, we used PLS-SEM and multi-group analysis (MGA) using SmartPLS 4.0 were used to analyse them, as the MGA technique helps comprehend the intents of different groups. In this study, we found that, except for the association between resources and deliverable quality, the PLS-MGA findings did not demonstrate statistically significant differences between the designated groups, namely Scrum and Kanban. This might imply that capable up-skilled personnel would have a greater impact on deliverable quality in the Kanban technique than Scrum in Agile software development.

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