SUCCESS FACTORS FOR ADOPTING VIRTUAL REALITY IN DISTRIBUTED SOFTWARE DEVELOPMENT TEAMS

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A RESEARCH PROJECT SUBMITTED TO THE SCHOOL OF COMPUTING AND INFORMATICS IN PARTIAL FULFILLLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE IN COMPUTER SCIENCE OF GRETSA UNIVERSITY

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DECLARATION

This project is my original work and has not been presented for award of degree or for any similar purpose in any other institution

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This project has been submitted with my approval as university supervisor

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Table of Contents

List of Tables

List of Figures

Abbreviations and Acronyms

VR – Virtual Reality

TAM- Technology Acceptance Model

Operational Definitions of Words

Technology Acceptance Model. Is a theoretical framework that seeks to explain and predict the acceptance and adoption of new information technologies by suggesting that an individual's intention to use a technology is determined by two primary factors: perceived usefulness (the degree to which the individual believes the technology enhances their performance) and perceived ease of use (the degree to which the individual believes the technology is easy to use)

Virtual Reality. Is a technology that creates a computer-generated immersive experience, simulating a three-dimensional environment that can be interacted with and explored by users.

ABSTRACT

This research project aimed to investigate the success factors for adopting VR in enhancing collaboration and communication within distributed software development teams. Software development companies face challenges in fostering effective collaboration and communication among geographically dispersed team members. VR offers an immersive shared virtual environment to enhance remote teamwork among the developers. The background to the study highlights the growing trend in distributed software development and the need for improved collaboration and communication practices thereby the adoption and utilization of VR technology. The problem statement emphasized on the lack of comprehensive understanding of the success factors for effectively adopting VR in distributed software development teams. This research study aimed to fill the existing knowledge gap proposed in the problem statement base on the following objectives; organizational factors, technological factors and individual (human) factors. The research used a null hypothesis to test for the factors that affect the adoption and implementation of VR technology within distributed software development teams. The methodology employed in this research involves mixed methods approach. Qualitative data was collected through interviews to gain insights into the experiences, challenges and perceptions of adoption of VR in distributed software development teams. Quantitative data was collected through questionnaires to gather information on the perceived impact of VR on collaboration, communication and the project outcomes. The data analysis methods include thematic analysis of qualitative data to identify key success factors on adoption of VR. Quantitative data was analyzed using statistical techniques to assess the relationship between VR adoption for collaboration and communication with software project outcomes. The sample size for the research study was 105 members comprised of company managers and software developers in the area of study. The area of study was in two companies; Ezen Partners and Rawlinz Designs involved in distributed software development. The sample size for this study was 104. The data findings were addressed as per individual objectives and in relation to the hypothesis. The research project findings showed a significant impact of the factors on successful adoption of VR technology and suggested some recommendations on future studies on VR technology researches

CHAPTER ONE: INTRODUCTION

1.0 Introduction

Distributed software development teams face challenges in collaboration and communication due to physical separation. Virtual Reality (VR) technology offers a potential solution by providing an immersive, shared environment for remote teams. However, the successful adoption of VR in this context remains unclear. This study aims to identify the key success factors organizational, technological, and individual that influence the effective use of VR to enhance collaboration and communication in distributed software development teams. The goal is to offer practical insights and recommendations for organizations seeking to integrate VR into their workflows and improve remote team dynamics.

1.1 Background to the Study

With the globalization of software development and the rise of remote work, organizations are increasingly relying on distributed software development to tap into global talent pool to meet the demands of the rapidly changing market (Agerfalk et al, 2008). However, physical separation presents significant challenges in collaboration and communication among team members, leading to coordination issues resulting into reduced productivity and suboptimal project outcomes. However, despite its potential benefits, the successful adoption of VR in such teams remains a challenge therefore, there is a need to identify key success factors that can facilitate effective use of VR in distributed software development teams.

The successful integration and utilization of VR in enhancing collaboration and communication in distributed software development teams present a challenge in current software development field. Although previous research has explored the potential benefits of VR technology in facilitating remote teamwork (Fernandes et al, 2006), there is a gap regarding the specific success factors for adoption and utilization of VR technology within distributed software development teams (Noghabaei et al, 2020). The problem at hand is the lack of a comprehensive understanding of the success factors for adopting VR to enhance collaboration and communication in distributed software development teams. This knowledge gap hinders organizations from making informed decisions regarding VR implementation. Furthermore, the problem is intensified by the limitations of existing collaboration and communication tools, which

often fail to provide an immersive and engaging experience to bridge the physical separation gap (Fernandes et al, 2006). As a result, distributed software development teams struggle to establish the sense of co-presence to establish effective collaboration and communication practices leading to inefficiencies and project delays.

The research was conducted within two software development companies; Rawlinz Designs and Ezen Partners located in Nairobi and Kiambu county respectively with a total population of one 105 members. This research aimed to fill the existing knowledge gap by examining the experiences and perceptions of teams who have adopted or experimented with VR technology.

1.2 Statement of Research Problem

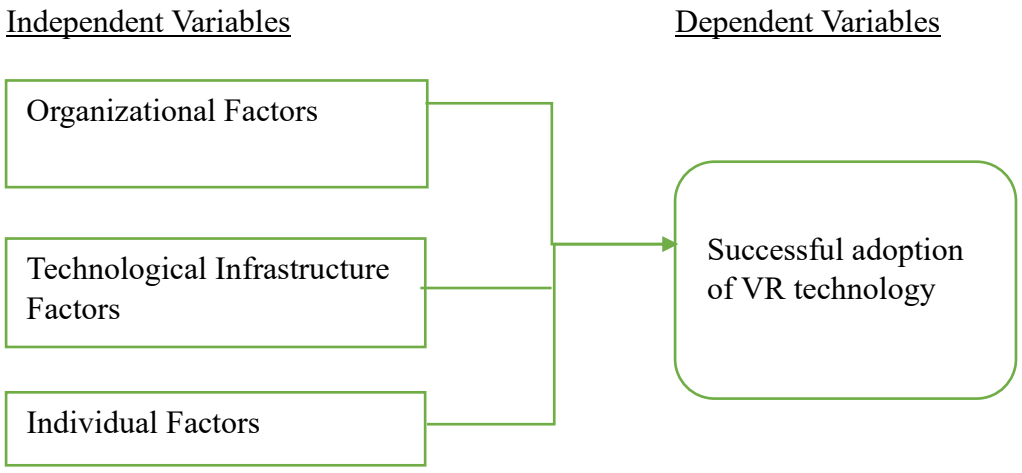
The problem at hand is the lack of comprehensive understanding regarding the success factors that influence the adoption of VR in distributed software development teams. This knowledge gap hinders organizations from making informed decisions regarding VR implementation (Fernandes et al, 2006).

1.3 Purpose of the Study

The study aimed to identify and examine the success factors that contribute to the successful adoption of VR in enhancing collaboration and communication within distributed software development teams. It aimed to fill the existing knowledge gap and provide practical guidance for organizations and practitioners looking to leverage VR technology to enhance collaboration and communication in distributed software development settings. Finally, the study aimed to contribute to the advancement of knowledge in this area and informed decision-making regarding the adoption and implementation of VR in distributed software development teams.

1.4 Conceptual Framework

Figure 1: Conceptual Framework



1.5 Objectives of the Study

1.5.1 General Objective

To investigate the success factors for adopting virtual reality in enhancing collaboration and communication in distributed software development teams.

1.5.2 Specific Objectives

i. To investigate the influence of organizational factors on the adoption of VR technology in distributed software development teams.

ii. The impact of technological infrastructure on the effective use of VR technology within distributed software development teams.

iii. To analyse influence of individual factors on the adoption and acceptance of VR technology among team members in distributed software development teams.

1.6 Research Questions

i. What are the key success factors that contribute to the effective adoption of virtual reality (VR) in enhancing collaboration and communication within distributed software development teams?

ii. How does organizational factors influence the adoption of VR technology for collaboration and communication within distributed software development teams?

iii. How does technological infrastructure factors impact on the adoption of VR technology for collaboration and communication within distributed software development teams?

iv. How does individual factors influence the adoption of VR technology for collaboration and communication within distributed software development teams?

1.7 Hypothesis of the Study

The below hypotheses were formulated based on the specific objectives of the study and provide a clear null hypothesis (H_o) for each relationship to be tested. They served as a basis for empirical investigation to determine the presence or absence of significant relationships between the variables under study.

$H_0$1. There is no significant relationship between organizational factors and the adoption of VR in distributed software development teams.

$H_0$2. Technological factors do not significantly influence use of VR in distributed software development teams.

H_0 3. Individual factors have no significant impact on the adoption and acceptance of VR technology among team members in distributed software development teams**.**

1.8 Significance of the Study

The significance of study lied in its potential to improve communication, collaboration and software development outcomes in distributed software development teams through effective adoption of VR technology. The findings benefited software development teams, organizations, VR technology providers, researchers and have broader implications for future technology adoption in various collaborative domains.

i. Software Development Teams. The findings of this study provided valuable insights into the success factors for adopting VR in enhancing collaboration and communication within distributed software development teams. By understanding these factors, distributed software development teams can make informed decisions about integrating VR technology into their workflow, leading to improved teamwork, enhanced communication and more efficient software development processes.

ii. Organizations and Project Managers. The study's findings benefited organizations and project managers who are responsible for managing distributed software

development teams. By identifying the success factors for adopting VR, organizations and project managers can effectively plan and implement VR technology to optimize collaboration and communication within their teams. This can result in increased productivity and improved outcomes by better team performance.

iii. VR Technology Providers. The study's insights were valuable to VR technology providers who develop and offer solutions for collaborative software development. By understanding the success factors, providers can design and refine their VR platforms to cater specific needs of distributed software development teams better. This can lead to the development of more effective VR tools that meet the requirements of the industry.

iv. Researchers. The study contributed to the existing body of knowledge on the adoption of VR in distributed software development teams. It provided researchers with a deeper understanding of the factors that influence the successful adoption of VR technology and its impact on collaboration and communication. The study's findings can inspire further research in the field on the effective use of VR in distributed software development teams.

1.9 Scope of the Study

This study focused on two distributed software development teams; Rawlinz Designs and Ezen Partners. The study primarily relied on existing literature, empirical research and established theories related to the adoption of VR technology in collaboration and communication in distributed software development teams. The study focused specifically on the successful adoption of VR technology as a means of enhancing collaboration within distributed software development teams.

1.10 Limitations of the Study

The study acknowledged the following limitations and implementing appropriate mitigation strategies helped minimize the potential constraints to provide meaningful insights into the success factors for adopting VR in enhancing communication in distributed software development teams.

Limited Generalizability**:** The findings of this study may lack generalizability to other contexts beyond distributed software development teams. Efforts were made to gather

a diverse sample although the specific characteristics and dynamics of the software development domain may limit the generalizability of the findings.

Mitigation strategy: Clearly acknowledging the specific context of the study in the research findings and discuss the potential implications and transferability of the results to other domains.

Relying on self-reported Data: The study's data collection relies on self-reported information from participants from questionnaires or interviews which poses the possibility of response biases or recall bias, which may impact the accuracy and reliability of the data.

Mitigation strategy**:** Emphasizing anonymity and confidentiality to encourage participants to provide honest and accurate responses.

Technological Limitations: VR technology is continuously evolving and there may be advancements in the technology that emerge during the study. The study's findings may not capture the most up-to-date technological developments or tools available in the field.

Mitigation strategy: Conducting a thorough literature review and keeping the research alongside the latest advancements in VR technology.

1.11 Assumptions

The availability and accessibility of VR technology. The research assumed that VR technology is readily available and accessible for adoption by distributed software development teams.

Collaborative work culture. The research assumes that distributed software development teams have a collaborative work culture through teamwork, communication and share knowledge. It assumes that teams are open to leverage VR technology to enhance their collaborative practices and improve communication channels.

Population has technical proficiency. The research assumes that team members possess a certain level of technical proficiency and familiarity with VR technology usage. It assumes that team members have the necessary skills to operate and utilize VR tools.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter examines a variety of academic scholars' publications that are related to the research topic. This chapter does this by discussing the success factors for successful adoption with citations from relevant articles and use of VR technology to enhance collaboration and communication in distributed software development teams. The factors include technological infrastructure factors, organizational factors and individual (human) factors and their impact on successful adoption of VR technology. TAM was employed as the theoretical framework developed to explain and predict the relationship of the factors influencing VR adoption. This chapter also provides identified gaps in the reviewed literature.

2.2 Factors Affecting Adoption of VR Technology

The successful adoption of VR in distributed software development teams depends on various factors. They include;

Technological Infrastructure Factors (Aloudat et al, 2022). The availability of necessary technological infrastructure, such as high-speed internet connections, powerful computing resources, and VR hardware (Zhang et al, 2020), significantly impacts the feasibility of implementing VR in distributed teams.

Organizational Factors. (Sebillo et al, 2016) Management support and buy-in, resource allocation, and training and education programs, plays a vital role in the successful integration of VR into distributed software development teams.

Individual (human) factors. (Lenberg et al, 2015) Attitudes of team members towards the adoption of VR, individual perceptions of VR technology, (wang et al,2022) attitudes towards collaboration and communication, and (Alout et al, 2022) the willingness to embrace new tools and technologies.

2.3 Organizational Factors in Technology Adoption

Management support and buy-in. (Sebillo et al, 2016). If the management recognizes the potential benefits of VR technology in enhancing collaboration and communication, it can provide the necessary resources and support for VR adoption. It would also involve aligning the adoption of VR with the organization's strategic goals and vision.

Resource allocation (Hein et al 2016). This involves providing the necessary hardware and software infrastructure such as VR headsets, computing resources and a reliable network. Allocating adequate resources ensures that team members have access to the VR technology and can fully utilize it for collaboration and communication purposes.

Training and Skill Development (Rajabi et al, 2022). Training sessions can familiarize team members with VR technology, its functionalities and applications for collaboration and communication. By investing in training and skill development, organizations can ensure that team members are competent to effectively use VR tools and platforms.

2.4 Technological Infrastructure Factors on Technology Adoption

High-speed Internet Connection (Zhang et al, 2020). VR applications often require a significant amount of data transfer and real-time streaming of immersive virtual environments. To ensure a smooth experience, distributed software development team members need access to fast and stable internet connections to handle the VR applications.

VR Hardware and Devices (Zhang et al, 2020). For effective utilization of VR technology, software development teams need access to appropriate VR devices. They include; VR headsets, motion controllers and other peripheral devices necessary for immersive interactions. Availability of up-to-date VR hardware ensures that team members can fully utilize VR technology benefits.

Compatibility with Software Development Tools (Sheng, et al, 1999). Integrating VR technology requires compatibility with existing software development tools. VR platforms and applications should be compatible with software development tools such as integrated development environments (IDEs), version control systems and issue tracking systems. Compatibility ensures that teams members can leverage VR technology without disrupting their established development processes.

2.5 Individual (human) Factors on adoption and acceptance of VR technology

Perceived Usefulness and Ease of Use (Lenberg et al, 2015). If team members perceive VR as a valuable tool that can enhance their collaboration and communication and is user-friendly, they would certainly be open to adopt and embrace VR technology.

Prior Experience and Familiarity (Wang et al 2022). Team members who have had previous exposure to VR or have experience with similar technologies would be open to adopt and embrace VR in their work since they have familiarity with the concepts and potential benefits of VR encouraging them to embrace adoption of the technology.

Personal Motivation and Attitude towards Technology (Shah et al, 2022). Team members who are enthusiastic about their work and eager to explore innovative tools are more likely to embrace VR technology. Team members with a positive attitude towards technology were willing to explore new tools and methodologies therefore they're more likely to adopt VR compared to those who have a negative attitude to change because they would be hesitant to embrace adoption of a new technology.

2.6 Theoretical frameworks

Technology Acceptance Model: TAM proposes that the perceived usefulness and perceived use of a technology influence an individual's intention to adopt and use a technology. In the context of VR technology adoption in distributed software development teams, TAM provided insights into individual factors that influence team members' acceptance of VR, such as their perceived usefulness in enhancing collaboration and communication and their perceived ease of use of VR.

Expert Advice: Researchers such as (Davis et al, 1989) have extensively studied TAM and its application in various domains. Their work suggests that perceived usefulness and perceived ease are strong determinants of technology acceptance and usage. Therefore, applying TAM to the proposed study can help identify the factors that influence the adoption of VR technology among distributed software development teams. By examining team members' perceptions of the usefulness and ease of use of VR technology in enhancing collaboration in distributed software development teams.

2.7 Summary of identified gaps in the reviewed literature

i. Inadequate Exploration of VR Technology Adoption. This literature review reveals lack of a comprehensive exploration of the factors influencing the adoption of VR technology among team members in distributed software development teams. While some studies touch on the benefits of VR, there is a need for more in-depth analysis of the specific factors that drive or hinder adoption. Barrett et al. (2023).
ii. Limited Consideration of Training and Skill Development. The literature review highlights a gap in understanding the role of training programs and skill

development initiatives in promoting the adoption and effective use of VR technology. The impact of providing adequate training and support for team members to acquire the necessary VR skills and competencies should be explored further. (Mitchell, P. 2002).

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Research Design

The research design that was used for this study is a mixed-methods design combining both quantitative and qualitative approaches which allows for comprehensive investigation, taking into account both numerical and in-depth insights from the participants. The use of a mixed-methods design enabled a holistic understanding of the success factors for adopting VR in distributed software development teams.

3.2 Study Area

The study area was in two distributed software development companies, Ezen Partners and Rawlinz Designs. The choice was made based on that they are established software development companies with tech professionals and conducting the research there would be insightful and economical therefore making it suitable for the research.

3.3 Target Population

The target population of the study included managers and IT team members in Ezen Partners and Rawlinz Designs software development companies. The companies have a total population of 140 members comprising of five chief officers in Ezen partners, forty-five members in the development and engineering team and twenty-six product and design officers. In Rawlinz Designs there are ten chief officers, fifty development and engineering team members, six product and design officers. The study targeted chief officers and selected IT team members involved in distributed software development projects where team members rely on collaboration and communication technologies for their work.

3.4 Sampling Techniques

The sampling technique that was be used for this study is purposive sampling as the target population is specific and well-defined. The study targeted managers and IT teams within Ezen Partners and Rawlinz Designs software development companies.

3.5 Sample Size

The sample size for this study was determined based on Cochran’s formula for estimating proportions. Cochran's formula is a statistical formula used to determine the sample size required for a given population size and level of precision.

$$n = \frac{N}{(1 + N(e)^2)}$$

n = sample size

N = the population size (target population size)

e = level of precision / acceptable sampling error (e = 0.05)

As the population size is known to be 140, the level of precision (e) was be set at 0.05, which is a commonly used level of precision in social science research.

Using Cochran's formula, the sample size required for this study was be:

$$n = \frac{140}{(1 + 105(0.05)^2)} = 104$$

3.6 Measurement of variables

Table 1: Measurement of Variables

Variable	**Measures/ Indicators**	**Measurement Scale**	**Question Number (section)**
Technological Infrastructure Factors	Installation of up-to-date devices and compatibility	Ordinal scale by using Likert scales	Section 1
Organizational Factors	Organizational support and number of departments using VR technology	Ordinal scale by using Likert scales	Section 2
Individual (human) Factors	Individual perceptions and technical skills	Ordinal scale by using Likert scales	Section 3

3.7 Research Instruments

Questionnaires were administered to all team members to collect self-reported data in a standardized manner since they offer ease of administration, scalability and the ability to collect data from a large number of participants. In this study, they were used to collect quantitative data on participants' perceptions, attitudes and willingness towards VR technology adoption. The questionnaires were constructed based on validated

scales and items that have been used in previous research. TAM was applied to provide a theoretical framework to develop relevant questions to address context of VR adoption in distributed software development teams.

An open-ended question was used in the study to allow for in-depth exploration of participants' experiences and perspectives to gather rich qualitative data to complement quantitative findings obtained from the questionnaires.

3.8 Validity of Measures

Face Validity which is the extent of outward appearance to which a measurement instrument can measure the intended construct. Face validity was established by ensuring that the questionnaire items and interview questions are relevant, clear and directly related to the research topic. A pilot test was conducted with a small group of participants to assess their understanding of the questions. Based on their feedback, necessary modifications were made to enhance the face validity of the research instruments.

Context validity was established by carefully selecting and constructing questionnaire items and interview questions that comprehensively cover the research objectives. Expert judgement was sought to review and evaluate the context validity of the instruments to ensure that they adequately represent the construct of interest.

3.9 Reliability of Measures

The reliability of the survey measurements was evaluated using Cronbach's alpha coefficient. It measures the extent to which the items in a scale are correlated with each other, indicating the degree of consistency of the measurement. In this study, after administering the questionnaire Cronbach's Alpha coefficient was calculated for each construct being measured.

3.10 Data Collection Techniques

A Structured questionnaire was developed consisting of multiple-choice closed ended questions and an open-ended question. The questionnaire was distributed to participants electronically through online platforms and via email. Participants completed the questionnaires at their convenience and shared their responses of their perceptions and experiences regarding the adoption of VR technology in distributed software development teams. An open-ended question was included in the questionnaire to

explore participants' perspectives on the individual (human) factors influential for adopting VR technology for collaboration and communication.

3.11 Data analysis

Organizational factors data was analyzed through descriptive statistics to analyze variables such as organizational culture, team dynamics and leadership styles. In addition, inferential statistics was employed to explore the relationship between organizational factors and the successful adoption of VR technology.

Table 2: Data Analysis

Hypothesis	**Hypothesis test**	**Statistical model**
Hypothesis 1	Null	Regression analysis
Hypothesis 2	Null	Regression analysis
Hypothesis 3	Null	Regression analysis

Technological factors data was analyzed through descriptive analysis to summarize and analyze the technological factors such as availability and accessibility of VR hardware and software.

Correction analysis was utilized to explore the relationships between individual factors and the adoption and acceptance of VR technology.

Qualitative data findings were represented in textual format using quotes, excerpts and narrative from both questionnaires data to highlight key themes, patterns and insights that were derived from the findings.

3.12 Logistical and Ethical Considerations

During the research, the following logistical considerations were observed by the researcher during the entire research period;

i. Time management by planning and allocating sufficient time for data collection, analysis and reporting to meet project deadlines and objectives.
ii. Establishing secure and reliable systems for storing and managing the collected data, ensuring privacy, confidentiality and data integrity throughout the research process

During the research, the following ethical considerations were observed by the researcher during the entire research period;

i. Obtaining informed consent from all participants, clearly explaining the purpose of the study, voluntary participation and data handling procedures.
ii. Ensuring anonymity and confidentiality to protect the privacy and confidentiality of participants' personal information and research data ensuring data is anonymized and securely stored.
iii. Ensuring that participation in the study is voluntary, and participants have the rights to withdraw at any time without facing any negative consequences.
iv. Seeking ethical approval from the relevant institutional review board or ethics committee, complying with ethical guidelines and regulations provided by the companies.

CHAPTER FOUR: FINDINGS AND DISCUSSION

4.1 Introduction

This chapter aims to provide a comprehensive discussion of the key findings from the data analysis conducted for this study. Each objective was addressed individually with an in-depth interpretation of the related results. The major findings are also evaluated in relation to the hypotheses and existing literature on VR adoption within distributed software development.

4.2 Overview of the Findings

The study sought to investigate the success factors for VR adoption to enhance communication and collaboration within distributed software development teams. Quantitative data was collected through questionnaires distributed to software developers at Rawlinz Designs and Ezen Partners software development companies in Kiambu and Nairobi respectively. The findings provide insights into the perceived factors of VR adoption within distributed software development teams.

4.3 Respondent Rate

A total of 100 responses were collected out of a target population of 104 from the software development team members in the two companies, Rawlinz Designs and Ezen Partners on success factors for VR adoption for distributed software development. The high response rate of 96% indicates that the vast majority of developers who were invited in the survey chose to respond, since response rates over 85% are generally considered very good in research.

4.3.1 Gender

Of the 100 usable responses received:

The majority of the respondents (63%) were male, while 37% were female. This gender distribution provided insights that most software developers involved in distributed software development are men.

Table 3: Gender Responses

Gender	Frequency	Percentage	Cumulative percentage
Male	63	63.0%	63.0%

Female	37	37.0%	100%
Total	100	100%	

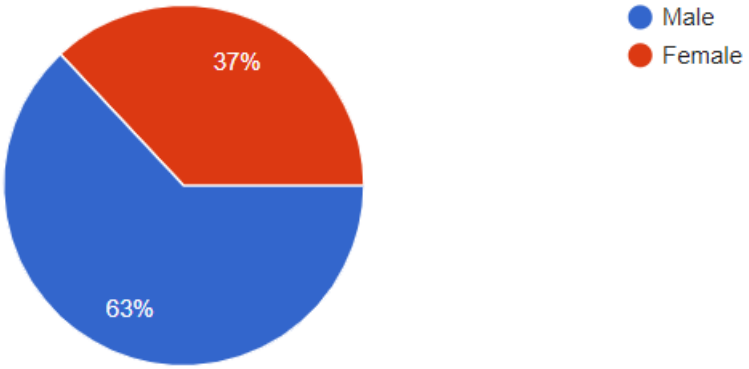


Figure 2: Gender Responses Pie chart

4.4 Influence of Organizational Factors in VR Technology Adoption

The survey results showed that the companies practice collaborative software development with the companies providing necessary support to provide the resources and needed training to the software development team members. However, there are some organizational challenges like high cost of VR hardware acquisition and resistance to adopt VR from using previous collaboration ways. This aligns with the research that organizational factors have an impact on the adoption of VR for collaboration and communication within distributed software development teams.

Table 4: Organizational Factors Statistics

Statistics

		How would you rate the level of collaboration between different departments	How supportive is your organization's management in adopting VR	Does your organization provide training and resources for employees	In your opinion what are the organizational barriers to adopting VR
N	Valid	100	100	100	100
	Missing	0	0	0	0
Mean		3.73	3.36	.59	3.47
Median		4	4.00	1.00	4.00
Std. Deviation		1.109	1.243	.494	.822
Minimum		1	1	0	1
Maximum		5	5	1	4

The level of collaboration between departments is significant as it is above average with a mean of 3.73. The respondent rate show that collaboration is key within distributed software development.

Supportive organization management is key to the adoption of VR as the management is the decision-making body within an organization and a mean of 4.0 show that the organization management bodies are supportive as it is above average by providing training and VR resources to developers and other employers involved in the distributed software development chain of production.

However, there are some organizational barriers towards the adoption of VR technology since there is a mean of 4.0 on the response rate of the study. Some organizational barriers are the high cost of VR hardware acquisition and resistance to change from traditional collaboration ways.

4.5 The influence of Technological Infrastructure Factors in VR Technology Adoption

The survey results showed that both software development companies have reliable internet connection to support VR technology. In addition, the companies also have acquired upto date VR hardware and also have upto date software to support collaboration and communication between the software development team members. However, some members experience some integration challenges of the VR tools with

their development tools and sometimes poor network connectivity. This supports the notion that technological infrastructure is a determinant to the adoption of VR technology in collaboration.

Table 5: Technological Infrastructure Statistics

Statistics

		How reliable is your internet connectivity for supporting VR technology	How would you rate the availability of VR compatible up to date hardware and software in your organization	In your opinion what are the main technological challenges in implementing VR technology
N	Valid	100	100	100
	Missing	0	0	0
Mean		3.38	3.87	1.79
Median		3.50	4.00	2.00
Std. Deviation		1.262	.960	.729
Minimum		1	1	1
Maximum		5	5	3

Having reliable internet connectivity is above average across all respondents according to the mean of 3.38. It suggests that, on average, respondents show an average level of reliable internet connectivity.

A mean of 4.0 on the availability of VR compatible up to date hardware and software in respondents' organizations suggests that use of VR technology in distributed software is commonly practised.

A mean value of 2.0 in technological challenges faced by developers while using VR technology suggests tat there are technological challenges associated with the use of VR technology like slow internet connection and VR devices incompatibility with existing workflows.

4.6 The influence of Individual (human) factors on the adoption of VR Technology.

Individual (human) factors are a key consideration as it involves individual opinions and perceptions towards the adoption of VR technology in workflow. The following factors were collected and analyzed from the research.

Responses from the research:

i. Technical skills on operating VR devices"
ii. Personal motivation and attitude towards VR"
iii. Prior experience with VR devices"
iv. Poor familiarity with VR collaboration devices"
v. Resistance to change"

The frequency of each response:

i. Technical skills on operating VR devices: 40 times
ii. Personal motivation and attitude towards VR: 8 times
iii. Prior experience with VR devices: 32 times
iv. Poor familiarity with VR collaboration devices: 5 times
v. Resistance to change: 15 times

The most common factors were:

Technical skills on operating VR devices is the most frequently mentioned factor, followed closely by personal motivation and attitude towards VR.

Patterns and insights:

The high frequency of “technical skills on operating VR devices” suggests that individuals recognize the importance of having the necessary skills to effectively use VR technology in distributed software development teams.

The emphasis on “personal motivation and attitude towards VR technology” indicates that individuals' interest and enthusiasm for VR technology play a significant role in its adoption and use as it influences personal choices on acceptance.

The mention of “prior experience with VR devices” suggests that individuals who have previous exposure to VR technology are more likely to adopt it in a distributed software development team setting.

Lastly, the mentions of "poor familiarity with VR collaboration devices and resistance to change" highlight potential barriers to the adoption and utilization of VR technology in distributed software development teams.

4.7 Correlations

Table 6: Correlation Table

Correlations

		How reliable is your internet connectivity for s	How supportive is your organization's management in adopting VR	How would you rate the level of collaboration between different departments	How would you rate the availability of VR compatible up to date
How reliable is your internet connectivity for supporting	Pearson Correlation	1	.678**	.471**	.233*
	Sig. (2-tailed)		.000	.000	.020
	N	100	100	100	100
How supportive is your organization's management in adopting VR	Pearson Correlation	.678**	1	.496**	.285**
	Sig. (2-tailed)	.000		.000	.004
	N	100	100	100	100
How would you rate the level of collaboration between different	Pearson Correlation	.471**	.496**	1	.574**
	Sig. (2-tailed)	.000	.000		.000
	N	100	100	100	100
How would you rate the availability of VR compatible up to date	Pearson Correlation	.233*	.285**	.574**	1
	Sig. (2-tailed)	.020	.004	.000	
	N	100	100	100	100

There is a strong positive correlation (Pearson Correlation = 0.678) between the reliability of internet connectivity for supporting VR and the supportiveness of the organization's management in adopting VR. This suggests that the organizations that have better internet connectivity are more likely to have supportive management for adopting VR technologies.

There is a strong positive correlation (Pearson Correlation = 0.471) between the reliability of internet connectivity and the level of collaboration between different departments. This indicates that organizations with better internet connectivity tend to have higher levels of collaboration between departments.

There is a strong positive correlation (Pearson Correlation = 0.496) between management support towards VR technology adoption and the level of collaboration between different departments. This suggests that organizations with supportive management towards adopting VR tend to have better collaboration between departments involved in distributed software development chain.

There is a strong positive correlation (Pearson Correlation = 0.574) between the availability of VR-compatible up-to-date equipment and the level of collaboration between different departments. This indicates that organizations with up-to date VR-compatible equipment are more likely to have higher levels of collaboration between departments.

4.8 Regressions

Table 7: Regression table

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.134	.397		2.856	.005
	How supportive is your organization's management in adopting VR	.527	.083	.520	6.326	.000
	Does your organization provide training and resources for employees	.800	.209	.314	3.834	.000
	How would you rate the availability of VR compatible up-to date	.500	.097	.500	.505	.996

4.9 Testing of Hypothesis

Significance level is set at 0.05

Table 8: Testing of hypothesis

Hypothesis	**Value (P)**	**Verdict**
H_{01}. There is no significant relationship between organizational factors and the	-0.527	Accept

adoption of VR in distributed software development teams.		
H_{02}. Technological factors do not significantly influence use of VR in distributed software development teams.	-0.800	Accept
H_{03}. Individual factors have no significant impact on the adoption and acceptance of VR technology among team members in distributed software development teams**.**	-0.500	Accept

In the first hypotheses, the result has proven that it is true that organizational factors (e.g. Resistance to change to existing communication and collaboration practices.) have influence on the successful adoption of VR technology for communication and collaboration within distributed software development.

The finding indicated that technological infrastructure factors (e.g. network bandwidth and network latency) have influence on the successful adoption of VR technology as the devices are subject to internet connectivity.

The study showed there is a significant association between individual (human) factors and the successful adoption of VR technology for communication and collaboration as they are the specific user's perception and attitude towards VR technology.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMENDATIONS

5.1 Introduction

This chapter presents a summary of the key findings from the study, conclusions drawn from the results, recommendations, and suggestions for further research on the successful adoption of VR technology for communication and collaboration within distributed software development teams. This chapter aims to concisely communicate the implications and significance of research.

5.2 Summary

The study sought to investigate three main objectives:

To analyze the influence of organizational factors on the adoption of VR technology for collaboration and communication within distributed software development teams. The findings showed over 75% of respondents agreed several organizational factors like organization workflows and management perceptions, and decisions have influence on successful adoption of VR technology.

To examine the impact of technological infrastructure factors on the adoption of VR technology for collaboration and communication within distributed software development teams. Between 78- 85% of the responses collected showed having a reliable internet connection and upto date VR hardware and software would significantly support successful adoption of VR technology.

To investigate the influence of individual factors on adoption of VR technology for collaboration and communication within distributed software development teams. More than 80% of the responses collected from the study showed that personal motivation and attitude and having technical skills on operating VR devices influences the acceptance to use VR at personal level of collaboration and communication.

5.3 Conclusions

The research concludes that individual, technological infrastructure and organizational factors like having adequate technical skills on operating VR devices, having a reliable internet connection, and aligning organization workflows respectively have the potential to facilitate successful adoption of VR technology within distributed software development teams. Respondents recognized the above factors as they are crucial and important considerations for successful adoption and VR technology implementation.

5.4 Recommendations for Policy or Practice

Software development companies involved in distributed software development practices should pilot test the use of VR technology for communication and collaboration in their workflows. Lessons leaned from initial implementation should be used to refine technical implementation and user experience. Adoption rates may be increased through public-private partnerships that raise awareness of the technology's benefits like having immersive 3D environments that simulate real word spaces for interaction in work engagements like code review, debugging and collaborative programming among distributed software development companies. Overtime, the goal should be transitioning to full use of VR technology within distributed software development practices. VR devices production standards are needed to ensure interoperability between different platforms used in design and development of software for ease in compatibility of the VR devices with existing software development platforms.

5.5 Recommendations for Further Research

1. Future studies could analyse distributed software development collaboration and communication statistics both before and after implementation of VR technology and gather qualitative feedback to understand factors that influence adoption of VR technology among different distributed software development teams. This would allow real-world monitoring of technical performance and scalability under heavy workloads.
2. Conduct longitudinal studies to track the adoption and utilization of virtual reality (VR) technology in distributed software development teams over time. This would provide insights into the long-term success factors, challenges, and evolution of VR adoption in these teams.
3. Investigate how the adoption of VR technology affects team dynamics, collaboration processes, and productivity in distributed software development teams. Explore the role of VR in enhancing communication, fostering creativity, and improving task coordination among team members.

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APPENDENCIES

1.1 QUESTIONNAIRE

This questionnaire is divided into three sections; technological infrastructure factors, organizational factors and individual (human) factors.

Section 1: Technological Infrastructure Factors

Which gender do you belong to?

i. *Male [ ]*
ii. *Female [ ]*

On a scale of 1 to 5, *(1= Extremely limited availability, 2=Limited availability, 3= Moderate Accessible, 4= Good availability, 5= Very available)*

(1= Extremely unreliable, 2=Unreliable, 3=Moderately reliable, 4= Reliable, 5=Highly reliable)

Table 9: Technological factors questionnaire

How reliable is your internet connectivity for supporting VR technology?	1	2	3	4	5
How would you rate the availability of VR-compatible up-to-date hardware and software in your organization?					

What types of VR devices and platforms does your organization currently use for collaboration and communication? *(Select all that apply)*

i. *Standalone VR headsets* **[ ]**
ii. *Tethered VR headsets* **[ ]**
iii. *Mobile VR headsets* **[ ]**
iv. *Web-based platforms* **[ ]**

Which of the following technological challenges do you experience while implementing VR technology?

i. *Poor network bandwidth and high network latency [ ]*
ii. *Integration challenges of VR tools with existing workflows and project management tools. [ ]*

iii. *Unreliable content delivery networks [ ]*

What aspects of VR technology do you find most beneficial for enhancing collaboration and communication in distributed software development?

i. *Immersive 3D environments that simulate real world spaces for interaction in work engagements [ ]*
ii. *Gesture and body tracking to communicate and interact using natural body tracking like gestures and body movements [ ]*
iii. *Collaborative code review, debugging and programming in virtual environments [ ]*
iv. *Virtual meetings and presentations in 3D immersive environments [ ]*

Section 2: Organizational Factors

On a scale of 1 to 5,

(1 = Not supportive, 2= Somehow supportive, 3= Neutral, 4= supportive, 5 =Highly supportive)
(1= minimal collaboration, 2=limited collaboration, 3= Moderate Collaboration, 4=Good collaboration, 5= Excellent collaboration)

Table 10: Organizational factors questionnaire

How supportive is your organization's management in adopting VR technology for collaboration and communication?	1	2	3	4	5
How would you rate the level of collaboration between different departments in your organization when it comes to adopting and utilizing VR technology?					

Does your organization provide training and resources for employees to learn and use VR technology

i. *Yes* **[ ]**
ii. *No* **[ ]**

If yes, please select the types of training and resources provided in your company.

i. *Interactive tutorials and workshops for training with roleplay exercise [ ]*

ii. *Training with VR simulations and virtual environments relevant to software development [ ]*
iii. *Providing documentation and knowledge resources* [ ]

In your opinion, what are the organizational barriers to adopting VR technology for enhancing collaboration and communication in distributed software development teams?

i. *High cost of VR hardware acquisition for team members [ ]*
ii. *Resistance to change to existing communication and collaboration practices. [ ]*
iii. *Lack of awareness to stakeholders and decision makers on potential VR technology applications [ ]*
iv. *Integration challenges with existing software development workflows [ ]*

Section 3: Individual (Human) Factors

What aspects of VR technology do you find most challenging or limiting for enhancing collaboration and communication in distributed software development

i. *High cost and inaccessibility of VR hardware to software development team members [ ]*
ii. *Technical issues and unstable VR applications like hardware failures and connectivity issues [ ]*
iii. *Physical discomfort and fatigue on prolonged use of VR headsets*

In your opinion, what individual factors (*e.g. personal motivation and attitude towards VR, technical skills on operating VR devices, Prior experience with VR devices, Resistance to change etc*.) influence the adoption and utilization of VR technology for collaboration and communication in distributed software development teams? (open ended question)

1.2 BUDGET

An estimate of financial expenditures for the research.

Table 11: Budget

ITEM	BUDGET (KSH)
Researcher's Fare and lunch	10,000
Token for interviewees (both teams)	40,000
Cloud Data Storage fee	6,000
Online Survey Platform Fee	15,000
Printing Research Materials	4,000
Data Bundles	4,000
Laptop	40,000
Researcher's Salary	50,000
Total	**169,000**

1.3 MAPS

The location of the study was at the company offices where the physical interviews were conducted depending on the convenience of team leaders and senior developers. The offices of Ezen Partners are located in Nairobi CBD and those of Rawlinz Designs are located at Ruiru.

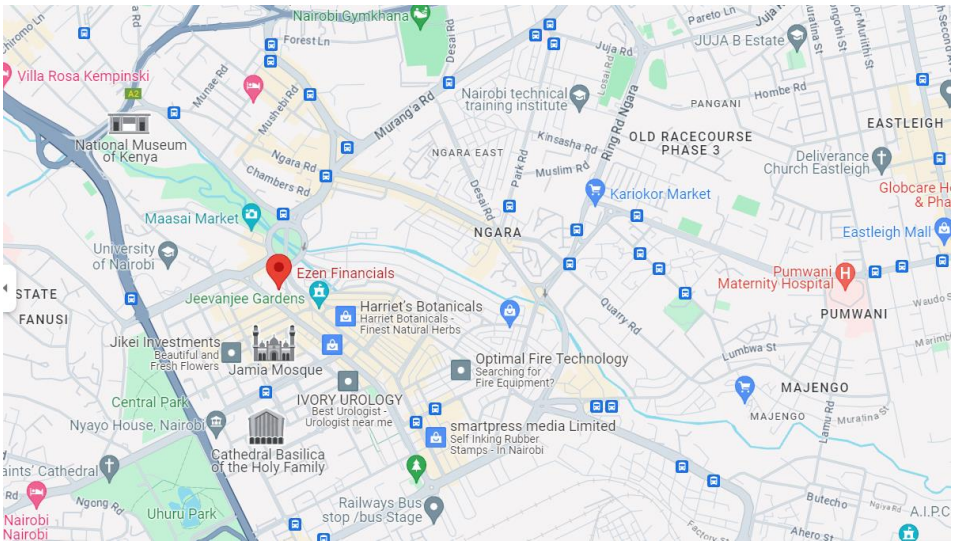


Figure 3: Ezen Partners Location

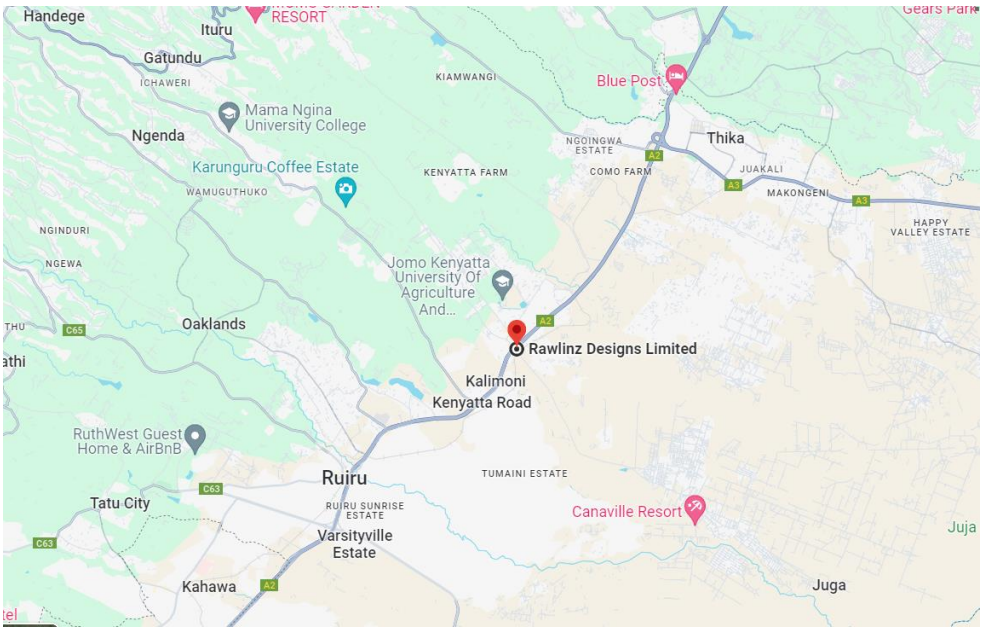
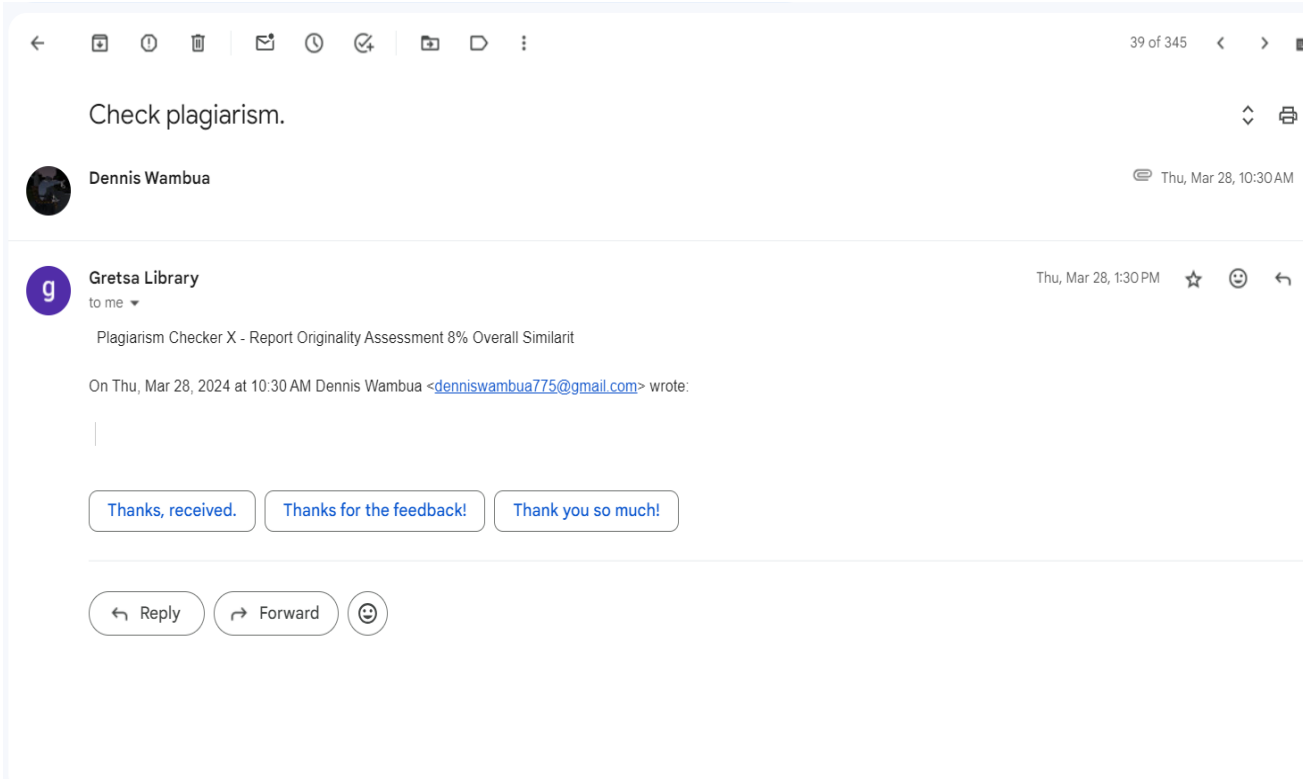


Figure 4: Rawlinz Designs Map Location

1.4 WORK PLAN

Table 12: Work plan

ACTIVITY	**TIME IN WEEKS**
Pilot Test and Expert Judgement (validity of measures)	Week 1
Seek Ethical Approval	Week 1
Data collection (both teams)	Week 2 &3
Data analysis	Week 4
Data presentation	Week 5


39 of 345
Check plagiarism.
Dennis Wambua
Thu, Mar 28, 10:30 AM
Gretsa Library
to me
Thu, Mar 28, 1:30 PM
Plagiarism Checker X - Report Originality Assessment 8% Overall Similarit
On Thu, Mar 28, 2024 at 10:30 AM Dennis Wambua <denniswambua775@gmail.com> wrote:
Thanks, received.
Thanks for the feedback!
Thank you so much!
Reply
Forward