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A Framework for the Adoption of Hackathon for Teaching and Learning of Computer Programming

Thesis submitted in fulfillment of the requirements for the degree
of Doctor of Philosophy in Information Systems
In the Faculty of Applied and Computer Sciences

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Date: September 2022

DECLARATION

I _____, declare that this thesis is my original work and has not been submitted in its entirety or in part for a degree at any university or institution for similar or any other degree award. I also declare that this research work does not violate the right of others, as all the sources cited or quoted are indicated and acknowledged utilising a comprehensive list of references.

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Signature Date

Approved for final submission as we confirm that the candidate carried out the work reported in this thesis under our supervision.

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Tranos Zuva Date

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Anneke Harmse Date

DEDICATION

This thesis is dedicated to the Almighty who gave me the instruction to go ahead with the research when I was interested in pursuing other commitments and equipped me with the resources, strength, wisdom, and inspiration to run with it. May His name forever be praised.

To the memory of my late dad, you taught me to be dogged and resolute in getting and attaining whatever I wanted in life. I made it. Your words will always be with me to guide me today, tomorrow, and forever. To my wife and family, thank you for your support, commitment, encouragement, and support throughout this journey.

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ABSTRACT

Hackathons originated from the evolution and revolution of computers. They were primarily designed as a collaborative tool for solving computer-related tasks or theorising new possibilities based on specific infrastructures. With the prevalence of technology and the drive for digital evolution, the role of hackathons becomes increasingly essential, making its presence known in almost every domain with the potential to transform the business world and society at large. However, hackathons in the educational domain cannot be understood in the same way as their counterparts in a purely business or career-driven domain because of their special nature. Given that educational institutions in South Africa are still in the early stages of using hackathons, studying factors affecting hackathon adoption for teaching and learning computer programming is critical and timely. The research aimed to investigate and find factors that had a bearing on hackathon adoption for teaching and learning computer programming. To realise the aim, a systematic literature review was conducted. Then, a conceptual framework was developed that has its variables (attitude (ATT), effort expectancy (EE), facilitating conditions (FC), perceived usefulness (PU), relative advantage (RA), performance expectancy (PE), perceived ease of use (PEOU), subjective norm (SN), and behavioural intention (BI)) based on an extensive literature review. A questionnaire-based survey was conducted to test the model. The web-based questionnaire was administered to two hundred forty-nine (249) South African Information Technology programming students. Reliability of variables was measured, and all the variables had a co-efficient of 0.7 and greater. Factor analysis was applied and the PEOU failed to fulfil the requirement and so it was dropped. Descriptive and inferential statistics were applied to further analyse the data collected. The correlation result indicated that all the remaining variables in the conceptual framework are significant and have a positive relationship PU ($r = 0.615$), RA ($r = 0.657$), PE ($r = 0.597$), SE ($r = 0.660$), ATT ($r = 0.440$), EE ($\rho < 0.520$), SN ($r = 0.441$), and FC ($r = 0.357$) have a positive relationship with behavioural intention ($\rho < 0.001$) to adopt hackathon. The regression result indicated that the following variables (PU ($\beta = 0.141, \rho = 0.036$), RA ($\beta = 0.142, \rho = 0.045$), PE ($\beta = 0.205, \rho = 0.002$) and SE ($\beta = 0.330, \rho = 0.000$) have a positive influence on students' hackathon adoption. The research study managed to validate the conceptual framework indicating variables that influence or have a relationship with BI. The developed framework forms the main contribution of this research study. The developed framework can be used to assist educators with the variables that have a strong bearing on the adoption of hackathon in education. The adoption of hackathon in education will contribute towards transforming the learning environment from a teacher-centred to a learner-centred one by facilitating a form of social learning where knowledge is created amongst students when interacting, thereby, building relationships, and supporting the learning that happens from

cooperation, dependence and helping each other. In conclusion, the introduction of hackathons in education in computer programming can revolutionise the programming landscape in South Africa and around the world during this period of the fourth industrial revolution.

Keywords: Computer programming, hackathon, learning, teaching, technology, adoption.

LIST OF ACRONYMS

PHRASE	ABBREVIATION
Assembly Language	AL
Association for Computing Machinery	ACM
Attitude	ATT
Augmented Tam or Combined Tam and TPB	C-TAMTPB
Behavioural Intention	BI
Computer Programming	CP
Computer Science	CS
Decomposed Theory of Planned Behaviour	DTPB
Diffusion of Innovation	DOI
Effort Expectancy	EE
Exploratory Factor Analysis	EFA
Extended Technology Acceptance Model	TAM 2
Facilitating Condition	FC
Higher Education	HE
High-Level Languages	HLL
Information and Communication Technology	ICT
Information System	IS
Information Technology	IT
Integrated Tam	TAM3
Kaiser-Meyer-Olkin	KMO

Low-Level Language	LLL
Machine Language	ML
Maximum Likelihood	ML
Perceived Ease of Use	PEOU
Perceived Usefulness	PU
Performance Expectancy	PE
Principal Axis Factoring	PAF
Principal Component Analysis	PCA
Relative Advantage	RA
Self-Efficacy	SE
Subjective Norm	SN
Systematic Literature Review	SLR
Technology Acceptance Model	TAM
Technology, Organisation, And Environment	TOE
Theory of Planned Behaviour	TPB
Theory of Reasoned Action	TRA
Unified Theory of Acceptance and Use of Technology	UTAUT
United States of America	USA

PUBLICATIONS AND CONFERENCE PRESENTATIONS

From this thesis, the following publications have already been presented and published:

Journal Paper

OYETADE, K., ZUVA, T. & HARMSE, A. 2022 Factors Influencing Hackathon Adoption for Learning Information Technology (IT) Programming Modules. *TEMS Journal, 11(3).*

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OYETADE, K., ZUVA, T. & HARMSE, A. 2020. Technology adoption in education: A systematic literature review. *Advances in Science, Technology Engineering Systems,* 5, 108-112.

Conference Papers

OYETADE, K., ZUVA, T. & HARMSE, A. 2022. Intention to use Hackathon by Information Technology Programming Students. *In: 12th International Conference on Information Systems and Advanced Technologies, 26th – 27th August 2022,* Springer Nature.

OYETADE, K., ZUVA, T. & HARMSE, A. 2020. A Review of the Determinant Factors of Technology Adoption. *In: SILHAVY, R., ed. Applied Informatics and Cybernetics in Intelligent Systems*, 2020 Cham. Springer International Publishing, 274-286.

OYETADE, K. E., HARMSE, A. & ZUVA, T. 2020. Technology Adoption Factors in Education: A Review. 2020. *In: International Conference on Artificial Intelligence, Big Data, Computing and Data Communication Systems* (icABCD), 6-7 Aug. 2020 Durban, South Africa. IEEE, 1-10.

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CHAPTER 1 INTRODUCTION

1.1 Introduction

The study aims to investigate the factors that determine the adoption of hackathon for teaching and learning of computer programming (CP) in Higher Education Institutions (HEIs). This chapter will review the background of Information and Communication Technology (ICT), the evolution of computer programming and how student engagement in CP programming courses has not yielded positive results. The study's problem statement on the poor success rate of CP in Higher Education (HE) institutions leading to high dropout rate and low skilled programmers precedes the framework of the study, which outlines the aim and objective, research questions, justification of the study, developed research hypothesis, and contribution to knowledge. The chapter concludes with the overall summary of the whole thesis.

1.2 Background of the Study

Over the years, ICT has become prevalent in shaping and playing a vital role in several facets of human lives (Gunbatar, 2018). ICT is gradually evolving in terms of how businesses operate, communicate, and access information and services (Shahroom and Hussin, 2018). In recent times, ICT is changing the 21st century model of education and making an impact on higher education. The exponential growth in the ICT industry has created a significant demand for skilled Computer Science (CS) graduates in HEI. However, passing CP courses is an essential requirement in obtaining a higher degree certificate (Chetty and Barlow-Jones, 2014; Law et al., 2010; Smith and Ali, 2018). CP is the act of understanding a problem, generating a solution, and presenting the solution so that a computer can use the solution to solve the problem (Moström, 2011; Sharma and Shen, 2018).

While some computer programming learning tasks are simple and require intuition and quick judgment. Other learning task are more complex and require a systematic approach to analyse, develop a solution, and implement a plan of action (Garov and Veselinova, 2017). Developing problem-solving skills, critical thinking, logical reasoning, accuracy, analogic reasoning, and comparison between alternative solutions in generating a solution to a given problem is an essential foundation that must be mastered by any student studying computer programming (Chetty and Barlow-Jones, 2012; Kalelioglu and Gülbahar, 2014; McCracken et al., 2001; Muller and Haberman, 2009).

However, many students find it challenging to develop problem-solving skills, which make them at risk of not passing CP courses in the university, leading to poor academic achievement in CP

courses (de Raadt et al., 2005; Garner, 2007; Huet et al., 2004; Rountree et al., 2004). This challenge may emanate from various factors that precede their entry into the university. The study tries to determine factors that limit the attainment of critical problem-solving and cognitive skills required to pass CP courses. In conclusion, it presents an hackathon approach that attempts to improve the development of good programming skills by helping students work as a team to create and design new ICT based innovation to a given task in a short time (Briscoe and Mulligan, 2014; Kolog et al., 2016).

1.3 Evolution of Computer Programming Languages

Programming is a vital skill in computer science that teaches logical thinking and is based on algorithms, data structures, programming languages, and environments (Porras et al., 2008). CP, which evolved as computers evolved, is developing a computer program to solve a particular task or problem (Shelly and Vermaat, 2013). It is also a detailed step-by-step set of instructions or sequence of actions that precisely instruct the computer what to do (Zelle, 2002).

According to Garner (2003), the following steps are presented in creating a computer programme:

- Define the problem: This makes the programmer decide accurate solutions to the problem.
- Plan the solution: The programmer designs a given problem by drawing a flowchart (a pictorial representation of a stepwise solution to a problem) or writing pseudocode (focusing on the programme logic without concerns about the precise syntax of a programming language) or both.
- Coding the program: translating the logic from the flowchart, pseudocode, or other tool to a programming language.
- Test and revise the algorithm: Testing the coded programme repeatedly for syntactical errors, which are fixed if found (debugged) until the programme is free of errors. The error-free programme is executed (run) to verify that it produces accurate results.

Programming languages comprise high-level languages (HLL), assembly language (AL) and low-level language (LLL) or machine language (ML). High-level languages are common English-like programming languages such as Basic, C, C++, and Java that computer programmers use because humans easily understand them. On the other hand, computers can only process instructions in machine language. Machine language is the programming language understood and obeyed by a machine (computer), an intuitive two characters binary language: (0 and 1), which is difficult to read and understand by humans. The compiler, interpreter or assembler is designed to convert a programme written in HLL into ML by working out instructions to give to the

computer which are needed because of the language barrier between humans and computers (Chetty, 2014; Knaggs and Welsh, 2004).

Algorithms form the foundation on which CS and Information Technology (IT) is built. Algorithms were pioneered by a Persian mathematician, Muhammad ibn Musa Khwarizmi who wrote one of the earliest mathematical textbooks known to man (Agarwal and Sen, 2014). An algorithm is a well-ordered collection of definite and effectively computable operations that result when executed within a specific time (Schneider and Gersting, 2018; Thomas, 2014). It can also be likened to a map or flowchart, which performs in a stepwise procedure to produce the same output information irrespective of the iteration once performed correctly (Schneider and Gersting, 2018).

FORTRAN, the first High Level Language (HLL) that resembled English-like statements or high-level statements, was developed once it became possible to write programs stored within the computer's memory (Backus, 1978, Forouzan and Mosharraf, 2008). Soon other languages, such as COBOL, Pascal and Basic, emerged (Chen et al., 2005; Goosen, 2008; Wirth, 1996). These languages provided a platform for converting algorithms into programs that could be executed on a computer (Bruce, 1996; Chen et al., 2005). To solve a problem, a computer programmer would develop an algorithm for the given problem and the algorithm would then be converted into a computer programme using languages, such as FORTRAN or COBOL. The programme would execute the instructions it contained to carry out the steps included in the programme. Such programs meant that tasks are automated, complex mathematical calculations are performed, and enormous amounts of information are processed. The programming industry rapidly grew and today, complex computer programming languages, such as Java, C++, are responsible for the computer being a powerful commodity to organisations and governments worldwide (Bruce, 1996; Chen et al., 2005; Schneider and Gersting, 2018).

Therefore, it became evident that well-trained computer programmers can develop solutions and write computer programs as computers and computer programming languages evolve. To this end, the Association for Computing Machinery (ACM) was established in 1947 to address the needs of workers employed to perform computer programming tasks (Kaarst-Brown and Guzman, 2005). Later, in October 1962, the first Department of Computer Science was established at Purdue University, in the United States of America (USA), and awarded its first Ph.D. degrees to students in 1966 (Rice and Rosen, 1994). Computer science as a discipline was born.

1.4 Poor Performance in CP

Computers and technologies are a part of almost every industry and are changing the way we live. This is true in education because they are used to delivering curriculum and offering

opportunities for students to interact with technology (Bulman and Fairlie, 2016; Hokanson and Hooper, 2000). More so, most students are taught how to use computers and web-based software, rather than create ways to use computational thinking and computer programming to solve authentic problems. One dimension of computer science that can easily be integrated into the curriculum is teaching students to programme which fosters problem-solving thinking skills like creativity and critical thinking that provide cognitive advantages to learning. This makes students valuable assets and prepares them for the modern workplace (Tengler et al., 2020; Zinth, 2016).

Research shows the computing industry is facing challenges to attract and retain more and diverse students needed to fill up programming jobs and solve computing problems. As a result of this growing need, programming is now recognised as a critical literacy skill in the computer science field (Gallivan et al., 2004; Rodriguez and Lehman, 2017; Watson and Li, 2014). However, as students make the decision to pursue and persist in a computing major, evidence from literature shows that CP modules at higher institutions are characterised by poor performance (Butler and Morgan, 2007; Corney et al., 2010; Garner, 2007; Rountree et al., 2004; Watson and Li, 2014).

Results from Corney et al. (2010) show that over 30% of students fail introductory programming every year while Watson and Li (2014) report a mean failure rate of 32% in introductory programming courses across multiple courses. The figure remains the same as reported in studies conducted in developing countries like India and Bangladesh (Ahmed et al., 2020; Pal, 2012). As a result, students drop out (Pappas et al., 2016) or decline to enrol for further IT programming modules (Ali and Shubra, 2010; Marginson et al., 2013; Watson and Li, 2014). Other factors contributing to this poor success rate are lack of programming experience, lack of time, complexity of programming concepts, lack of knowledge, lack of problem-solving skills or lack of resources to update one's knowledge, and meeting the requirements of programming syntax as the difficulties encountered by first-year programming students (Ahmed et al., 2020; Chetty and Barlow-Jones, 2012; Pappas et al., 2016).

While it can be easy to get distracted with reasons why students fail computer programming, offering programming courses using the hackathon approach will expose them to thinking strategies and ways to problem solve and better prepare them for 21st century skills that enable them to be successful in their future careers (Chetty and Barlow-Jones, 2014; Hoffman et al., 2019; Pappas et al., 2016).

1.5 Problem Statement

A noticeable trend in the above presentation is the low performance in CP courses despite the diffusion and utilisation of ICT and other technologies to teach CP. With the context of worldwide shortages of skilled programmers, this raises concerns to understand why students fail CP. Therefore, it is important to understand the causes of these failures as there is a relationship between success rate and attainment of problem-solving and cognitive skills that are needed to excel at the workplace.

Countless attempts to address this problem have been identified, which has its roots attributed to several causes such as social, educational, psychological, and cultural dimensions (Al-Zoubi and Younes, 2015). Nevertheless, individual differences of these students and diverse teaching practices of instructors play a vital role in students' academic achievement studying CP (Ahmed et al., 2020; Chetty and Barlow-Jones, 2014). Other variables, including demographic status, intelligence, digital literacy, academic background, socio-economic status, prior experience, and lack of problem-solving skills required to solve computational problems, affect learning CP. In addition, psychological factors and behavioural characteristics such as self-efficacy, attitudes, self-concept, and self-esteem have been used to explain factors influencing academic success (Fincher et al., 2005; Wilson and Shrock, 2001).

From the South African context, studies report that some students perform poorly in universities due to inadequate preparation for the academic demands of HE (Coetzee and Johl, 2009; De Beer and Van der Merwe, 2006). Pre-enrolment risk factors such as parenting, socio-economic status, family instability, under preparation for higher education, personal challenges and under-resourced schools contribute to student performance in HE (Barr and Parrett, 2001; Chetty, 2014). Unsatisfactory performance in HE by entry-level students has also been attributed to poor standards at matric level (Chetty and Barlow-Jones, 2012; Cliff et al., 2007; Weideman, 2003; Pappas et al., 2016).

Therefore, this research investigates and develop a framework for the adoption of hackathon for teaching and learning of CP to resolve the poor academic performance in CP.

1.6 Research Question

The study heeds the call by applying and integrating various models and theories of technology adoption to investigate factors that influence hackathon adoption. The research question is translated as:

i. What factors influence hackathon adoption for teaching and learning of CP?

The above research question can be further expressed with the following research sub-questions:

1.6.1 Sub-Research Questions

i. Which theories can help understand hackathon adoption for teaching and learning computer programming?
ii. How can the factors that explain hackathon adoption be shaped into a conceptual model?
iii. How can the hackathon adoption model be tested empirically?
iv. What recommendation can be suggested from the knowledge of the factors that influence hackathon adoption for teaching and learning computer programming?

1.7 Aim and Objectives

The study aims to investigate the framework that influence hackathon adoption for teaching and learning of CP. The aim was achieved through the following objectives:

i. To identify relevant theories that can be applied to examine factors influencing hackathon adoption for teaching and learning computer programming.
ii. To design an integrated conceptual model of the factors influencing hackathon adoption for teaching and learning computer programming.
iii. To evaluate and test the hackathon adoption model by investigating the different hypotheses developed.
iv. To recommend the factors that influence hackathon adoption based on the findings of the current study.

1.8 Justification of the Study

The research is motivated by the need to identify the factors affecting the adoption of hackathons for the teaching and learning of CP. The ability of HEI to produce skilled programming graduates has been questioned as the demand for qualified CP graduates is high relative to the low supply of graduates. Benefits of hackathon adoption include increased students' interest in the learning process, creativity, and collaboration in a mutually supportive environment (Angelidis et al., 2016; Briscoe and Mulligan, 2014; Calco and Veeck, 2015). However, research on the adoption of hackathons in academics is still low and primarily based on observation and assumptions (Porras et al., 2019). Thus, the research is significant as it is grounded on theoretical and empirical data contributing to the literature on students' behaviours towards hackathons. The study was conducted in South Africa (SA), a developing country, where investment in technological

innovation like hackathons is expected to play a significant role in the nation's key economic and academic development.

1.9 Contribution to Knowledge

The findings from this research investigation demonstrate theoretical and empirical contributions to the study of hackathon adoption is highlighted below.

The study contributes to knowledge by extending the understanding of hackathons and developing a conceptual model of hackathon adoption from a wide-ranging review of technology adoption literature. The successful empirical testing of the model would provide a high explanatory power of hackathon adoption and guide other researchers in identifying factors that can drive behavioural intention to adopt hackathon like curricula.

The study will offer a point of reference for future studies not only because it might serve to illuminate the current state of play within research in the field but also because they potentially open new research grounds about hackathons in academic and other contexts. Likewise, the research findings may prove helpful in guiding classroom-based or institution-based changes that increase academic achievement for all students.

Methodologically, the systematic review approach used to select the models from the technology adoption theoretical frameworks to develop the hackathon conceptual model to explain the factors influencing hackathon adoption is an addition to knowledge. The adaptation of constructs from valuable and reliable technology models resulted in developing a comprehensive and consistent model that identifies and analyses factors influencing the adoption of hackathon. The systematic review employed in the study is relevant to researchers and stakeholders as it broadens insight into hackathon adoption, thereby enabling them to make the right decisions regarding the adoption of innovations.

1.10 Research Methodology

To achieve the study’s purpose, the honeycomb method of research methodology, which displays connections between methods and its supporting rationale, was adopted as a framework to develop the proposed hackathon adoption framework. The framework is used in a quantitative paradigm by adopting the survey technique to allow a researcher to collect data and analyse it using descriptive and inferential statistics (Venkatesh et al., 2003). The survey method can propose possible associations between variables to produce models of these relations. The target population consisted of IT programming students from South African universities. A Likert-scale questionnaire, a form of closed question was developed to test and measure student perceptions

on hackathon adoption by indicating how much they agree or disagree with that statement. The questionnaire was designed for easy reading and understanding while the collected data were analysed using descriptive and inferential statistics with the Statistical Package for the Social Sciences (SPSS V27) software package.

1.11 Thesis Structure

The study comprises of six chapters, outlined as follows:

Chapter 1: Introduction

The chapter provides the background to computers, technology, and CP. It presents the aim, objectives, and research problem of the factors that influence hackathon adoption for teaching and learning of CP in HE institutions. Also, the motivation for the study and research methodology to collect the data for the factors influencing hackathon adoption is presented and concludes with the thesis outline.

Chapter 2: Hackathon Overview

An overview of the concept and review of hackathons applied in different field of study is presented. The literature review is informed by the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines from relevant academic databases. Certain eligibility criteria informed the screening and selection of materials. The findings are analysed and discussed.

Chapter 3: Technology Adoption

Theoretical models and frameworks that can be applied to understand the adoption of hackathon for teaching and learning is discussed in the third chapter of the study. These models and frameworks are analysed to identify factors and their relevance for designing a conceptual hackathon adoption model. The hackathon adoption model is then translated into a research hypothesis that will be tested in chapter five.

Chapter 4: Research Methodology

This chapter summarises the philosophical foundation from which the research methodology was derived. The sampling method and the methods by which the study's primary data were obtained are discussed. The statistical methods employed to analyse data and test relationships proposed in the conceptual model are discussed.

Chapter 5: Research Results

This chapter presents the survey data result in the form of a descriptive and inferential analysis of the factors influencing the hackathon adoption for teaching and learning of CP in HE institutions.

Chapter 6: Conclusion and Recommendations

The discussion of the result from chapter five highlights' issues identified in the analysis and interprets it as it relates the results to previous findings in the existing literature. The chapter discusses the conclusions and recommendations of the study grounded on the understanding of the research questions. It summarises the study's findings into a single model or framework of a hackathon. Lastly, the chapter presents the possible avenue for future research on CP's teaching and learning.

1.12 Chapter Summary

This chapter introduced this research with a clear explanation on the impact of computers and technology on our daily lives. The history of CP is presented, which dates as far back as the Persian era. Programming languages comprise high-level languages (HLL), assembly language (AL) and low-level language (LLL) or machine language (ML). This has led to the evolution of the programming industry which needs more computer science graduates to fill open positions in the growing sector. The pressure to fill up these positions and meet the pressing demands for skilled programming graduates is the identified research problem of the study.

This is followed by the aims, objectives, research question, justification of the study and the contribution to knowledge. The research methodology will lead the study to identify the factors influencing hackathon adoption for teaching and learning of computer programming. In conclusion, an outline of the entire thesis is offered for the reader to understand the structure of this doctoral dissertation.

CHAPTER 2 HACKATHON

2.1 Introduction

The current study aimed to investigate the factors that determine hackathon adoption for teaching and learning of CP. The aim assumed that hackathons offer great potential to stimulate students' interest in learning computer programming and therefore the study examined the benefits of hackathon to fulfil the first objective of the study (Briscoe and Mulligan, 2014; Nath, 2011). The chapter starts with the origin of hackathons and reviews hackathon related studies using the PRISMA guidelines to cover a complete range of literature. The PRISMA statement is a reporting guide designed to address poor reporting of systematic reviews as well as reflect developments in approaches to identifying, selecting, appraising, and synthesising selected studies from which future research priorities can be identified (Welch et al., 2016). It is promoted as a useful and comprehensive source of evidence for decision making that encourage completeness, transparency in reporting methods and results of systematic reviews (Page et al., 2021; Welch et al., 2016). The study searched for articles using defined criteria from IEEE, EBSCOhost, and Google Scholar database to extract data independently and to conduct an in-depth analysis of eligible articles. Based on the findings, discussion of the benefits, challenges, and limitations of the factors that influence hackathon adoption for teaching and learning of CP in HEI is presented.

2.2 Origin of Hackathon

Hackathon was derived from the word "hack" and "marathon". "Hack" is defined as a solution reached through intense innovation while "marathon" is defined as an event of definite span and concerted effort (Olson et al., 2017). Hacking is traced to an ancient innate belief held by the Romans to persist in the face of challenges by having a positive view, a strong mindset and taking the right action until a solution is found. Today, this mind-set is held by hackers and design thinkers to take chances and risk everything to evaluate the situation or problem until the right solution is found (Emesobum and Shchyhelska, 2016). In the 1990s and more recently, hackathons emerged when large organizations like Google, Facebook, and Microsoft began holding an internal hackathon to build new solutions, empower developers, recruit bright developers and lure developers to embrace new technologies (Briscoe and Mulligan, 2014; Calco and Veeck, 2015).

Hackathon is an event where various stakeholders such as researchers, developers and analysts from computing and non-computing related fields team up at a stated venue with short timelines on software projects to solve complex software-related problems, address technological challenges or build testable innovative technologies within a particular domain (Almogi et al.,

2016; Angelidis et al., 2016; Briscoe and Mulligan, 2014; Calco and Veeck, 2015; Hynes et al., 2016; Mtsweni and Abdullah, 2015). Hackathons are based on ideas developed in response to a clear problem statement with input from a diverse team and presented to a live audience (Hynes et al., 2016; Nandi and Mandernach, 2016; Wiggins et al., 2014). It is also known as a short time interactive innovation focusing on some use of computer skills (Porras et al., 2019). This has since become a regular phenomenon where several hackathons have been reported to be held worldwide (Calco and Veeck, 2015).

Hackathon events are most times named with postfixes such as "-fest" or "-jam" or "-camp" for instance hack fest, codefest, Robo-camp, game jam (Briscoe and Mulligan, 2014; Komssi et al., 2014). Hackfest is an abbreviation of hacking festival and codefest for code festival where the code in this context refers to the computer code. Game jams are hackathons for video game development while a hack day is an event that last a day. Hackathon are classified into focussed hackathon and social hackathon (Briscoe and Mulligan, 2014). Technologically, focused hackathons aim to develop explicit application, which are sometimes known as sprints or code sprints rather than those focusing on the application of a technology to a social challenge or business opportunity (Briscoe and Mulligan, 2014).

Hackathon were designed to encourage innovation with digital technologies in a large range of different spaces in the professional world such as open data, academia, music, fashion etc (Emesobum and Shchyhelska, 2016; Remshagen et al., 2018). Their adoption for educational, commercial, and civic purposes in recent times is increasing (Artiles and Wallace, 2013). Hackathons have been found to foster problem-solving, interest and creativity in students as they engage them in the learning process and retention of new information, for instance, hackathons for teens, college students, clean energy, grocery shopping, civic hackathons for government transparency and so on (Briscoe and Mulligan, 2014; Nath, 2011).

Hackathons are reported to inspire creativity and originality and provide a platform for group learning, idea generation, and collaboration, by bringing together people in a mutually supportive setting that brings about multiple positive outcomes for business and entrepreneurial activity (Angelidis et al., 2016; Briscoe and Mulligan, 2014; Calco and Veeck, 2015) Also, Briscoe and Mulligan (2014) found in their study that open source software projects (Linux or OpenBSD) are used to improve development issues or hackathons organised to build solutions that address social issues, for instance, helping adults cope with dementia while technology giants like Facebook, Microsoft, and Google organise hackathons to encourage fresh innovation like the Facebook's Like button. Likewise Trainer et al. (2016) reports that hackathons are used for software development for specific applications or business objectives and social issues for specific purposes**.**

In academics, research on hackathons was found to foster problem-solving, interest and creativity in students as they engage them in the learning process and are proven to increase lasting retention of new information (Tandon et al., 2017). Hackathon have demonstrated their robustness in explaining collaborations amongst participants. Comparing outcomes across reviewed literature discloses that expertise, research context, and country type shape how participants use physical interactions to advance technical work (Trainer et al., 2016). This will be a useful tool if a hackathon is adopted and applied in education to develop solutions to real world problems, unlike the traditional CP with no real-life scenarios (Mhlongo et al., 2020).

2.3 Research Outline: The Systematic Review

A comprehensive systematic review process is planned further to explain the diverse use of Hackathon in the following sections.

2.3.1 Literature Search

Using the PRISMA guidelines, the IEEE, EBSCOhost, and Google Scholar databases were used to provide a complete coverage of literatures from foremost authors in the computing field. Google Scholar database is free, and it was employed because it is easy to access and download resources while the IEEE and EBSCOhost databases were used to search for materials because my university is subscribed to the library granting the study easy access to download materials. The search keywords (hackathon) and (learning or education) were used to search for materials

2.3.2 Screening and Eligibility Criteria

From the search of the databases, we identified 140 articles that were related and relevant to hackathon. The title and abstract were scanned for the keywords to ensure the relevant articles were selected and applied using the inclusion criteria below.

- Studies on hackathon found in IEEE, EBSCOhost, and Google Scholar database
- Studies on hackathon published in conferences, workshops, and peer-reviewed journals
- Studies published in English

The exclusion criteria used to remove articles not relevant for the study were:

- Studies that were not peer-reviewed publications
- Studies not published in English (e.g., Arabic, Turkey, and Nordic)
- Studies without abstracts
- Studies where the use of hackathon is not comprehensible.

2.3.3 Quality Assessment

The 140 literature items identified were independently extracted using the following information from each study: authors, journal, year, country of origin. The countries, institutions, years, and journals were analysed. The country was determined based on the address of the first author. If the first author and corresponding author had more than one address, the first address was used for analysis. This process ensured the credibility of studies selected and ensured that the selected studies met the inclusion criteria.

2.3.4 Data Analysis

The Figure 2.1 depicts the sequence of steps followed in the systematic review process. One hundred and forty articles were identified from the database search using the literature search keywords. Duplicates were subsequently excluded leaving the study with one hundred and thirty studies. Titles and abstracts of the remaining items were reviewed, and studies that did not meet the criteria were screened and dropped leaving the study with forty-nine studies. Of those, eight were excluded because some did not specifically focus on hackathon; some looked at adoption that did not specifically target hackathon studies. A due diligence review to ensure appropriateness and relevance to the research study was applied. Finally, thirty-six studies were identified for further review.

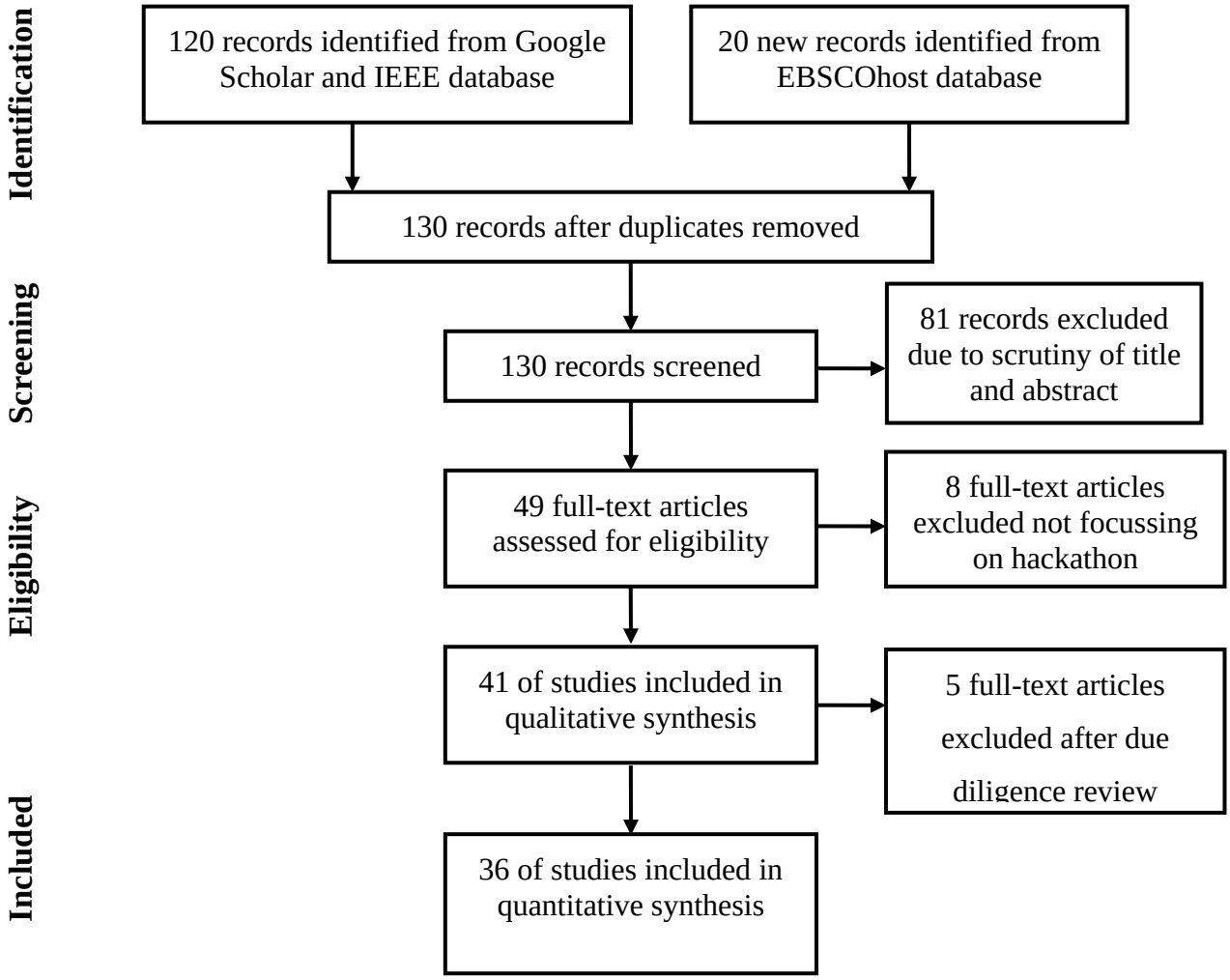

Figure 2-1: PRISMA systematic review flowchart: Adapted from (Yaghmour et al., 2019).

2.4 Studies Selected via the Systematic Review

Data extraction was conducted to extract data from the review of the thirty-six identified studies to analyse the characteristics of these articles. The outcomes of this analysis are presented in Table 2.1 and Figure 2.2 – 2.4. The next section presents the outcomes from data synthesis and analysis that were performed on the extracted data.

Table 2.1 presents an overview of the 36 studies on hackathon from which data were obtained and analysed in creating new ideas for social and academic development. The representation in Table 2.1 shows the publication are distributed across the nations in the continents of the world which implies no demographics location bias. Some publications were omitted because the articles were written in languages other than English (Arabic, Turkish and Nordic) which was part of our screening and eligibility criteria. This implies that hackathons are a topic of interest that is gaining popularity amongst researchers. Other findings from the review are presented in the following section.

Table 2-1: Hackathon experience from identified literature

S/N	Author(s)	Purpose of study	Country	Research Context
SR1	(Uys, 2019)	The study reports on the introduction of a hackathon style approach in a third year IS course at a South African University.	South Africa	University Education
SR2	(Porras et al., 2019)	The study finds out if hackathon have been used and implemented in education.	Finland	Education
SR3	(Saravi et al., 2018)	The study describes the value of an agile approach and the hackathon-style system engineering process to the development of design concepts of an aircraft	UK	Aviation
SR4	(Porras et al., 2008)	The study presents an overview of hackathon and code camps using literature review and multi-year experiences	Finland	Software Engineering Education
SR5	(Lyndon et al., 2018)	The study explores high school student learning experiences at a healthcare hackathon	USA	Student Healthcare Hackathon
SR6	(Paul, 2020)	The study was dedicated to generating interdisciplinary solutions to pressing environmental problems.	USA	Environmental Impact Hackathon

SR7	(Pe-Than et al., 2020)	The study provides an understanding of team processes and a range of outcomes of corporate hackathons.	USA	Corporate Hackathon
SR8	(Ferreira and Farias, 2018)	This study identifies the effect of eight motivation variables on participants of a citizen-sourcing hackathon in Brazil	Brazil	Public Sector
SR9	(Remshagen et al., 2018)	The study used the hackathon style approach using Scratch to create an animation about a given social theme for children between ages 12-17.	USA	Teen Programming
SR10	(Herala et al., 2019)	The study observes and analyses different industry cases for strategies and opinions on how and why organisations arrange hackathon events to extract information from their data, and its relation to the open data movement.	Finland	Public and Industrial
SR11	(Wang et al., 2018b)	The study addresses complex challenges in patient care and diversity in collaboration across business, medicine, engineering, and design	USA	Medical Innovation
SR12	(Wang et al., 2018a)	The study seeks to make medical innovation education and training more accessible and easily adoptable for academic medical centres using an extended hackathon course.	China, Brazil, USA, Hong Kong	Medical Innovation Education
SR13	(Horton et al., 2018)	This study used the hackathon events to estimate project-based learning environments by giving students opportunities to learn new technical skills through personal projects choices.	USA	Engineering Students

SR14	(Byrne et al., 2018)	The study explores the use of a constructivist/constructionist 21st Century educational model to meet the learning outcomes for the embedded systems of a new CS course.	UK	CS Education
SR15	(Nolte et al., 2018)	The study addresses the gap between potential outcomes of hackathon rather than focusing on the event itself by presenting results from participants of a large-scale corporate hackathon.	USA	Corporate Environment
SR16	(Kopeć et al., 2018)	The study reviews the effects of intergenerational cooperation on software development teams.	Poland	Older Adult/Software Engineering
SR17	(Olson et al., 2017)	To fast-track sustainable and effective medical technology invention and advance global health in resource-constrained locations.	India, Uganda, and the USA	Medical Technology
SR18	(Kienzler and Fontanesi, 2017)	To nurture an inquiry-driven, interactive setting where learners engage lecture material and new technologies in practical ways	USA	Global Health
SR19	(Alkema et al., 2017)	The study examines the rise of Agile practices at FNB Codefest to determine the bank's overall agile journey	South Africa	Banking
SR20	(Cooper et al., 2018)	Using a hackathon-style event to solve issues and innovate solutions within radiology, creating a collaborative environment between radiologists and relevant stakeholders across the medical community.	USA	Radiology
SR21	(La Place et al., 2017)	Their study explored how participants learn just enough to “hack” together (design) a feasible solution.	USA	Engineering Education

SR22	(Cobham et al., 2017a)	The study effectively utilises a hackathon as the genesis for creating sustainable student entrepreneurial activity.	UK	Student Entrepreneurial Activity
SR23	(Cobham et al., 2017b)	The study assesses the effectiveness of a hackathon-type event, to initiate a successful university student enterprise project and identify key elements of the event that might lead to a sustainable and effective student enterprise.	UK	Student Entrepreneurial Activity
SR24	(Almogi et al., 2016)	The study is dedicated to the development of linguistic tools for Tibetan Buddhist studies.	Israel	Language Development
SR25	(Page et al., 2016)	To re-evaluate new digital products from the firm's existing product range and markets.	UK	Product and Digital Interaction Design
SR26	(Kolog et al., 2016)	To analyse the perceived students' experience in a hackathon to design an application intended for people preparing for their death.	Finland	Digital Theology in CS
SR27	(Pogačar and Žižek, 2016)	To describe the details of an urban hackathon to harness the potential of stakeholders and IT's involvement in urban renewal and development.	Slovenia	Urban Development
SR28	(Silver et al., 2016)	To accelerate and improve healthcare solutions and to provide an educational experience for the rehabilitation patient population.	USA	Healthcare Rehabilitation
SR29	(Nandi and Mandernach, 2016)	To examine the informal learning aspect of Ohio State's yearly hackathon event	USA	Education
SR30	(Jones et al., 2015)	To organise a hackathon that brought together journalists, developers, and	USA	Journalism

		designers to build out ideas to reshape the future of digital news.		
SR31	(Mtsweni and Abdullah, 2015)	The study investigates if the hackathon approach is appropriate to stimulate and maintain students' interest in CS and change their false perceptions about CS.	South Africa	University Education
SR32	(Calco and Veeck, 2015)	The study helps students apply marketing concepts in creating innovative marketing projects in a marketing class in a Hackathon-like format.	USA	Introductory Marketing Course
SR33	(Linnell et al., 2014)	The study creates a technology using hackathon in an undergraduate class to benefit the homeless.	USA	Humanitarian Technology
SR34	(Soltani et al., 2014)	The study identifies factors leading to the success of hackathon contests	Sweden	eHealth, Open Data, eTourism, Space Environment, Education, Culture and Health
SR35	(Briscoe and Mulligan, 2014)	The study considers the hackathon phenomenon as an effective approach to encourage innovation with digital technologies in a large range of spaces.	USA	Digital Innovation
SR36	(Zapico et al., 2013)	The study uses the Green Hackathon events to broaden participation and collaboration in working with ICT technologies.	Sweden, UK, Finland, Greece, Switzerland	Sustainability

2.5 Results of the systematic review

This section presents the results of the outcomes from reviewed literature by summarising relevant characteristics of studies which include publication year and frequency, publication type,

demographic distribution, and the classification of the hackathon as explained in detail in the next section.

2.5.1 Publication Year and Frequency

A review of the articles shows the earliest publication on hackathon was in 2008. Hackathon is a new field that is being explored especially in the academic context. Figure 2.2 presents these identified studies along with the publication year and its publication outlet (book, conference proceedings and journal articles). The study identified a book publication and no identified publication on hackathon in journals articles between 2008 and 2013. Journal and conference publications began to rise between the years 2014 and 2020. A sharp increase in journal publications on hackathon was observed 2018. This implies an increase in research efforts on hackathon that is gaining attention. Yet again, only one book and conference proceedings were found in 2020. This could be attributed to the fact that the search was conducted early in 2020 when most publications are still in review or in print.

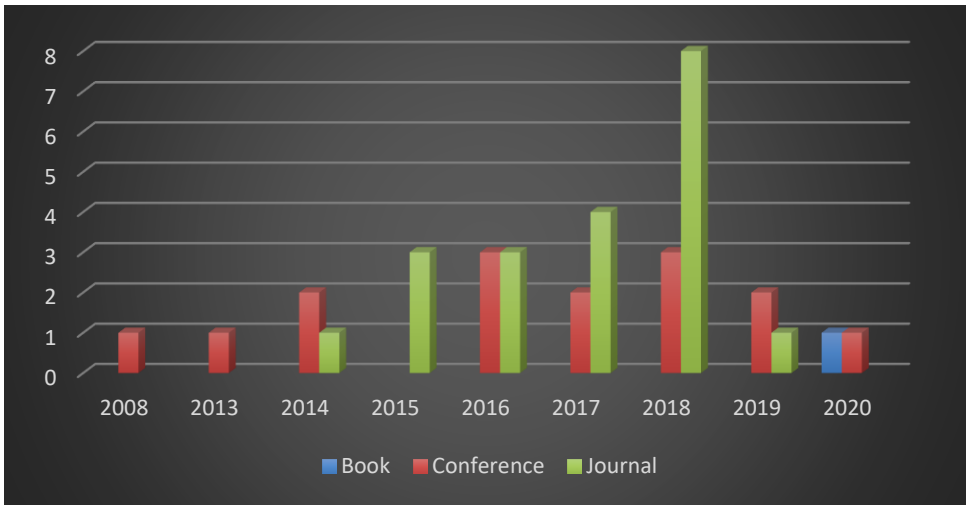

Figure 2-2: Publication frequency (author's calculation based on systematic review)

2.5.2 Publication Type

Figure 2.3 presents the pie chart representation of the publication type distribution. A simple majority of the range of identified publications for the review are journals (56%) which was followed by conference proceedings (41%) and books (3%) respectively. The different sources of articles for the study eliminates possible publication bias.

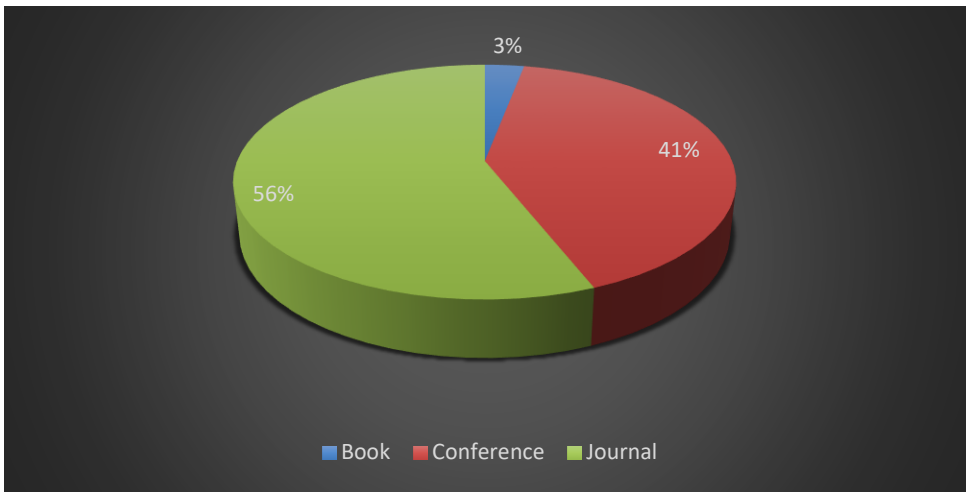

Figure 2-3: Publication type (author's calculation based on systematic review)

2.5.3 Demographic Distribution (study countries, regions)

The demographic location and distribution from which the primary studies on hackathon were conducted is presented in Figure 2.4. The study considered the author's location rather than where the paper was published as some of them had cross country empirical evidence. The United Kingdom, Finland, and the United States of America have more research outputs based on the application of hackathon in different areas. South Africa appears to lead in Africa in the adoption of hackathon in the African context. There needs to be a concerted effort to conduct more hackathon research to gain insight from the African perspective.

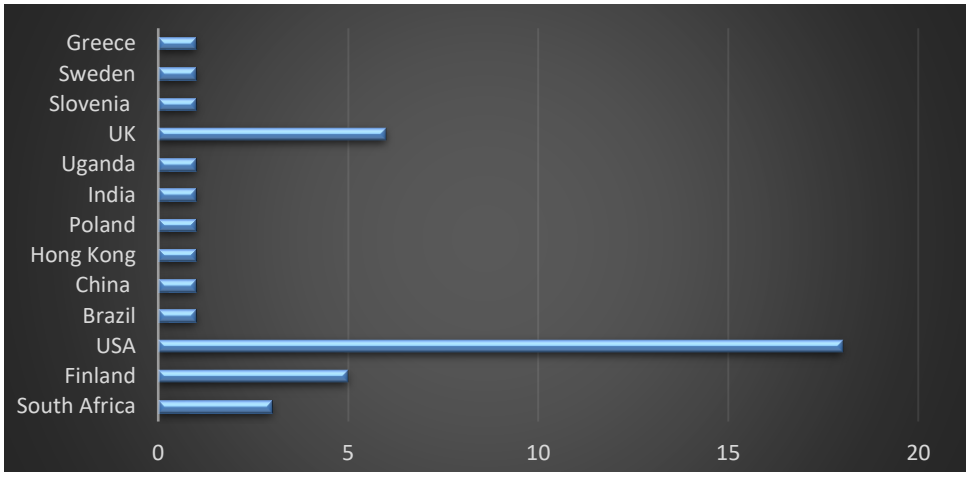

Figure 2-4: Primary studies by country (author's calculation based on systematic review)

2.5.4 Classification of Hackathon

Hackathons are classified as tech-centric or focus-centric (Briscoe and Mulligan, 2014; Calco and Veeck, 2015; Nandi and Mandernach, 2016). The primary studies are classified according to the formats of the hackathon. Three articles can be classified as tech-centric (Almogi et al., 2016; Nandi and Mandernach, 2016; Uys, 2019), thirty articles classified as focussed centric (Alkema et al., 2017; Briscoe and Mulligan, 2014; Byrne et al., 2018; Calco and Veeck, 2015; Cobham et al., 2017a; Cobham et al., 2017b; Cooper et al., 2018; Ferreira and Farias, 2018; Herala et al., 2019; Horton et al., 2018; Jones et al., 2015; Kienzler and Fontanesi, 2017; Kolog et al., 2016; Kopeć et al., 2018; La Place et al., 2017; Linnell et al., 2014; Lyndon et al., 2018; Mtsweni and Abdullah, 2015; Nolte et al., 2018; Olson et al., 2017; Page et al., 2016; Paul, 2020; Pogačar and Žižek, 2016; Porras et al., 2019; Remshagen et al., 2018; Saravi et al., 2018; Wang et al., 2018a; Wang et al., 2018b) while three studies could not be easily classified (Porras et al., 2019; Silver et al., 2016; Soltani et al., 2014).

Tech-centric hackathons focus on the development of software with a specific tech or application in mind. This can either be a single application, application type or technology specific. For example, Almogi et al. (2016) focussed on the development of linguistic tools for Tibetan Buddhist studies, a technology-specific hackathon focussed on creating applications that use a specific language framework or Application Programming Interface (API) from a single company or data source.

On the other hand, focus-centric hackathons target software development to address or contribute to a social issue or a business objective and could be considered applied hackathons. Focus-centric hackathons can be classified as socially oriented, demographic-specific, and company-internal. While socially oriented hackathons aim to address or contribute to an issue of social concern, demographic-specific hackathons are intended for programmers from specific demographic groups, such as women, students, or teenagers while company-internal hackathons encourage new product innovation amongst teams. The classification is presented in Table 2.2.

Table 2-2: Type and classification of the hackathon adoption studies

Authors	**Classification**	**Type**
(Pe-Than et al., 2020)	Focus Centric	Socially oriented hackathon.
(Saravi et al., 2018)	Focus Centric	Company internal to simulate the conceptual design of a proposed future aircraft.

(Porras et al., 2019)	Focus Centric	Socially oriented hackathon with outcomes like networks and connections, tacit skills, and receiving new ideas or solutions.
(Lyndon et al., 2018)	Focus Centric	Socially oriented hackathon to prepare the next generation for the multidisciplinary world of healthcare technology.
(Paul, 2020)	Focus Centric	Socially oriented hackathon dedicated to generating interdisciplinary solutions to pressing environmental problems.
(Ferreira and Farias, 2018)	Focus Centric	Socially oriented hackathon to propose an instrument to analyse the motivations to engage in citizen-sourcing initiatives in Brazil.
(Remshagen et al., 2018)	Focus Centric	Demographic specific hackathon where teens used Scratch to create an animation about a given social theme.
(Herala et al., 2019)	Focus Centric	Socially oriented hackathon to see if open data offers more visibility to the data and the organisation.
(Wang et al., 2018a)	Focus Centric	Socially oriented hackathon.
(Wang et al., 2018b)	Focus Centric	Socially oriented hackathon to teach undergraduate and graduate students a foundational skillset for medical innovation.
(Horton et al., 2018)	Focus Centric	Socially oriented hackathon to approximate project-based learning environments to give students the opportunity to learn new technical skills through projects of their choosing.
(Byrne et al., 2018)	Focus Centric	Socially oriented hackathon to see growth in embedded systems/practical experience because of the "learning by doing" pedagogical design by the hackathon like delivery method.

(Nolte et al., 2018)	Focus Centric	Socially oriented hackathon.
(Kopeć et al., 2018)	Focus Centric	Demographic-specific for older adult on software development.
(Olson et al., 2017)	Focus Centric	Socially oriented hackathon on health outcomes.
(Kienzler and Fontanesi, 2017)	Focus Centric	Socially oriented hackathon on undergraduate course to allow students gain and create knowledge about specific global health-related issues.
(Alkema et al., 2017)	Focus Centric	Company internal hackathon.
(Cooper et al., 2018)	Focus Centric	Socially oriented hackathon to solve issues within radiology.
(La Place et al., 2017)	Focus Centric	Socially oriented hackathon presenting methods of observation for self-regulated learning in a hackathon environment.
(Cobham et al., 2017a)	Focus Centric	Socially oriented hackathon on entrepreneur development.
(Cobham et al., 2017b)	Focus Centric	Socially oriented hackathon on entrepreneur development.
(Page et al., 2016)	Focus Centric	Socially oriented hackathon.
(Kolog et al., 2016)	Focus Centric	Socially oriented hackathon to brainstorm and demo the idea of an application for people preparing for their own death in a Digital Theology (DT) course
(Pogačar and Žižek, 2016)	Focus Centric	Socially oriented hackathon organised to solve the urban renewal problems in the city of Maribor.
(Jones et al., 2015)	Focus Centric	Socially oriented hackathon on digital news making.

(Mtsweni and Abdullah, 2015)	Focus Centric	Socially oriented hackathon to stimulate and maintain students' interest in computer science. Also encouraging their involvement in using their computing skills and knowledge in solving social pressing issues affecting their local communities.
(Calco and Veeck, 2015)	Focus Centric	Socially oriented hackathon.
(Linnell et al., 2014)	Focus Centric	Socially oriented hackathon for the homeless.
(Briscoe and Mulligan, 2014)	Focus Centric	Socially oriented hackathon on innovation and digital technology in urban spaces, including hardware hacking.
(Zapico et al., 2013)	Focus Centric	Socially oriented hackathon focused on innovation and digital technology in urban spaces, including hardware and software hacking. It also focuses on innovation and digital technology in urban spaces. Also, a focus-centric hackathon focused on innovation and digital technology in urban spaces, including hardware hacking (such as Arduino) as well as software hacking.
(Nandi and Mandernach, 2016)	Tech Centric	A project that introduced compulsory use of source control over a 3-day period.
(Uys, 2019)	Tech Centric	Delivery of a working system learning how to develop in Java on Android Studio, database development and using technologies such as XAMMP, PHP, umajin. Apps developed include residence control system eLincence app, clinic appointment app, soapy shine car wash etc.
(Almogi et al., 2016)	Tech Centric	Development of linguistic tools for Tibetan Buddhist studies

2.6 Discussion

The systematic literature review of the studies on hackathon has identified a range of compelling findings which are interpreted and presented in the following section in respect of the benefits, challenges, and the potential limitation are presented in the next sections.

2.6.1 Benefits

The benefits of the hackathon outcomes from the reviewed literature are vast and notable. Most of the papers agree on the following benefits of hackathon as an outcome of their findings which include development of technical and soft skills, learning new things, effective collaboration, and improvement to systems. A detailed explanation is presented in the next section.

2.6.1.1 Development of Technical and Soft Skills:

Six of the studies (Byrne et al., 2018; Calco and Veeck, 2015; Kienzler and Fontanesi, 2017; Kolog et al., 2016; Nandi and Mandernach, 2016; Nolte et al., 2018; Olson et al., 2017; Porras et al., 2019; Uys, 2019) reviewed cited that development of technical and soft skills is one of the benefits of participating in a hackathon. These skills include creativity, teamwork, project management skills, critical thinking, working well under pressure, improving confidence, and fixing bugs. In addition, working with different software, punctuality, responsibility, problem-solving, on-the-spot thinking, prioritisation, presentation skills, and creating prototypes for websites and tools are extremely valued activities that prepare the participants for their future work environment. The skills learned during the event are perceived as transferable to other fields which are seen as an opportunity for growth as evidenced by the sense of fulfilment expressed by hackathon participants yet having an enthusiastic, fun, and engaging experience (Byrne et al., 2018; Calco and Veeck, 2015; Kienzler and Fontanesi, 2017; Kolog et al., 2016; Lyndon et al., 2018; Nandi and Mandernach, 2016; Olson et al., 2017; Uys, 2019).

2.6.1.2 Learning New Things

It is evident from some of the reviewed literature that hackathons promote novel learning. Also, hackathons expose participants to new experiences irrespective of the goal and format of the hackathon. This is useful in solving academic and social pressing issues affecting their communities (Calco and Veeck, 2015; Horton et al., 2018; Kolog et al., 2016; Lyndon et al., 2018; Mtsweni and Abdullah, 2015; Nandi and Mandernach, 2016; Remshagen et al., 2018; Uys, 2019). Students reported they learnt to use new technologies and tools using a cross-platform development consisting of SMS services and Google APIs, valuable skills that accelerates the creation of new ideas (Uys, 2019).

In addition, hackathons are used in work environments to creatively solve problems, inspire originality, and innovativeness and make new products. Calco and Veeck (2015) further report that hackathon projects expose students to an engaging learning format where they apply specific concepts that they have learned in other fields combined with the experience gained by working in team settings. Furthermore, students grasp concepts easily due to the time-based nature of hackathons, and quickly teach and learn from their peers to produce a working product that enhances their technical skills (Nandi and Mandernach, 2016; Remshagen et al., 2018).

2.6.1.3 Effective Collaboration and Networking

Ten studies (Alkema et al., 2017; Briscoe and Mulligan, 2014; Cobham et al., 2017a; Cobham et al., 2017b; Kolog et al., 2016; La Place et al., 2017; Lyndon et al., 2018; Nandi and Mandernach, 2016; Olson et al., 2017; Saravi et al., 2018) cite networking and collaboration with teammates as a benefit of hackathon. This suggests hackathon get participants enthused into developing digital solutions, as well as potentially inspiring them to produce great work as well as an alternative to networking where new connections are formed. Kolog et al. (2016) report that collaboration among hackathon participants inspire motivation and confidence to think of creative ideas to solve problems. Also, participants reported being empowered by collaboration which strengthened their network beyond the scope of hackathon to form business ventures and where substantial connections were formed across different expertise and fields (Briscoe and Mulligan, 2014; Cobham et al., 2017a; Cobham et al., 2017b; Olson et al., 2017).

In addition, participants report that networking is a valuable mechanism to promote cultural diversities, and deal with demographics, and the intellectual capacities of participants. They were constantly in communication whether by learning or by sharing, and by discussing the direction of the project and addressing challenges of working in multidisciplinary teams (Cobham et al., 2017b; La Place et al., 2017; Nandi and Mandernach, 2016; Wang et al., 2018b). Similarly, Alkema et al. (2017) in their study found that the FNB Codefest provide an environment for participants to motivate themselves and collaborate with each other and thereby produce elements of technical excellence and quality Agile practices. Furthermore, Saravi et al. (2018) found networking at hackathons to be a very effective method to achieve a common level of understanding between teams.

2.6.1.4 Improvement to a System

Improvement of an existing system was identified as a benefit of hackathon from reviewed studies (Cooper et al., 2018; Herala et al., 2019; Olson et al., 2017; Pogačar and Žižek, 2016).

For instance, Pogačar and Žižek (2016) found that the urban hackathon establish new practices such as integrating advanced technology for the city of Maribor. Cooper et al. (2018) identified a collection of “pressure points” within radiology relating to workflow, patient relations, or technology. These pressure points were to improve patients’ access to medication, imaging reports, techniques in training radiologists, and to increase access to virtual health care platforms. Olson et al. (2017) present pointers to a strengthened health-focused innovation ecosystem from the emergence of a hackathon. These include practical business cases, a higher level of control, more natural communications, and incremental improvements of systems. Hence, the strengthened ecosystem creates a structure that is capable of solving healthcare challenges and offers more visibility to the data and the organisation (Herala et al., 2019).

2.6.2 Challenges

There are so many challenges that hackathon outcomes encounter when creating the environment to develop intended projects or ideas. These challenges include multi-diversity, small group size, time constraints, non-uniformity of skills and other related issues. A detailed explanation is presented in the next section.

2.6.2.1 Multi-diversity

Four of the primary studies (Byrne et al., 2018; Calco and Veeck, 2015; Kolog et al., 2016; Porras et al., 2019) find diversity to be a limitation to the implementation of hackathons. This limitation ranges from the participants and the format of the events. Each group consists of members from diverse religious and socio-cultural backgrounds. The diversity causes the organisers and participants to lose sight of the event’s purpose, which sometimes leaves participants confused. This poses a challenge in getting group members to agree on an idea, especially from people with diverse cultural backgrounds. As a result, creativity is hindered in coming up with a challenge (Kolog et al., 2016).

2.6.2.2 Small Group Size

Another challenge to the implementation of hackathon from the primary studies reviewed is the relatively small participation or a small number of teams per hackathon which does not give a fair representation or wider perspective from a larger hackathon participant or larger teams (Byrne et al., 2018; Horton et al., 2018; Lyndon et al., 2018; Wang et al., 2018b).

2.6.2.3 Time Constraints

Time was another factor cited in the reviewed literature. This factor varies from time taken to make decisions on tasks to undertake; to steps taken to achieve what they desired (La Place et al.,

2017). Time is a weakness for some technological developments in specialised fields in task completion (Byrne et al., 2018; Olson et al., 2017). In certain instances, follow-up from some surveys range between 2 and 40 months: however, typical medical device development ranges up to ten years depending on regulatory and clinical requirements.

2.6.2.4 Non-Uniformity of Skills

The diversity of participants in a team leads to non-uniformity of competence amongst them poses a risk and sometimes lowers the morale of students who feel they have nothing to contribute (Byrne et al., 2018; Olson et al., 2017). Since participation in hackathon is more of volunteering. It is difficult to select suitable participants considering that many different backgrounds could be better represented without the selection process leading to greater diversity in other settings.

2.6.2.5 Other Challenges Influencing the Adoption of Hackathons

- It does not accommodate teamwork (Remshagen et al., 2018).
- Student's attitudes and culture (Kienzler and Fontanesi, 2017; Olson et al., 2017).
- Hackathon organisation (Briscoe and Mulligan, 2014; Linnell et al., 2014).
- Time, resources, additional management and teaching skills from the lecturer (Uys, 2019).

2.6.3 Potential Limitations of the Review

Nonetheless, as the study followed the reporting guidelines by PRISMA (Page et al., 2021; Welch et al., 2016), it still has its limitations. For example, the review results are limited to the search keywords, which makes it excludes some studies. However, the study compensates for this by relying on related current literature reviews.

Considering the PRISMA method, it was possible to omit relevant publications due to the search method. This could have been improved by adding more publishers but increasing the number of publications complicates the filtering, duplicate elimination and grouping phase. Therefore, this study uses the IEEE, EBSCOhost, and Google Scholar database, which include bibliographic information from major computing publishers to make up for missed publications from other publishers.

Abstract filtering was another possible bias in the search results, thereby bringing inexactness into the search for relevant publications on hackathons. Moreover, the study understands that some of the abstracts suffer from incorrect formatting, for instance, sentences sticking together. This was compensated for by using multiple words and abbreviations in the search string and moving the inclusion/exclusion decisions to a later stage, and more detailed phases in case of

uncertainty. However, the limited publications found during snowballing indicates that the approach worked well.

2.7 Chapter Summary

This chapter applied the PRISMA method to identify and analyse hackathon literature. It provided an overview of the origin of hackathon and established the significance of hackathons in overcoming the identified challenges faced by students. The academic and social contributions of hackathons were explored.

From the review of literature, trends observed from 2008 to 2020 indicate that hackathon publication are steadily increasing which could be due to more awareness of hackathons. There was a sharp increase in year 2018 thereby generating more interest on its application in various areas of life. The publications consist of journal articles, conference proceedings and book chapters. 56% of the identified publications for the review are journals while 41% are conference proceedings and 3% are book chapter hereby eliminating possible publication bias. Also, the review identified that the publications were conducted across all continents of the world thereby eliminating demographic location bias. The study found that, despite cross continent research on hackathon, the developed nations have more research outputs than developing nations. More research needs to be conducted in this field to determine the benefits from the developing nation context to find pragmatic answers to the challenges that hinder the development and growth of hackathons in developing nations.

The reviewed papers agree that the benefits of hackathons includes the development of technical and soft skills, learning new things, effective collaboration, and improvement to systems which are recognised as significantly improving the operations of the adopting institutions through the provision of competitive advantages making them provide a basis for future studies and promote ideas for research areas not covered in detail by previous hackathon adoption as well as develop a core model of hackathon adoption that can be applied in any environment. The next chapter identifies and discusses the various theoretical models from literature that are used to explain the adoption of hackathons.

CHAPTER 3 THEORETICAL AND CONCEPTUAL FRAMEWORK

3.1 Introduction

The study aimed to investigate the factors determine hackathon adoption for teaching and learning of CP. The aim relied on an assumption that technology adoption theories are suitable to provide insight into how hackathon are adopted. This chapter introduces the models and theories that have been developed to describe and comprehend the implementation, acceptance, and adoption of new technologies or products by individuals. Since the research investigates the adoption of hackathon, it is important to have a background to those adoption theories and model and discuss them. The PRISMA framework in the previous chapter was used to search and select the articles used to review the literature on the use of hackathons and in effect help this chapter to understand and develop a conceptual model of hackathons to be tested. Research hypotheses were developed from the model and respondents were asked about their perceptions on each of the identified constructs of the model to assist in understanding hackathon adoption.

3.2 Theoretical Framework

A theoretical framework guides a researcher in his/her research by applying theories or a set of concepts drawn from one and the same theory to explain an event or shed some light on a particular phenomenon or research problem (Imenda, 2014). Since the study aimed to investigate the determining factors of hackathon adoption for teaching and learning of CP, the technology adoption theories guided and structured the study's body of knowledge. Technology adoption is an individual's choice in accepting or rejecting new technologies (Oyetade et al., 2020). It is important to understand technology adoption by examining its theories as applied in various fields to describe, analyse, and estimate the acceptance, implementation, and adoption of novel technologies. It is noteworthy to state that there is no single universal theory on innovation adoption. It seems improbable that a definitive one will emerge (Williams et al., 2015). These theories include TAM, DOI, TPB, TRA, TAM2, TAM3, TOE, Decomposed –TPB, UTAUT, among others.

3.2.1 Diffusion of Innovation Theory (DOI)

DOI was developed to analyse the spread of innovations in society at individual and organisational levels (Nazari et al., 2013; Rogers, 2002). It is based on innovation, communication channel, time and social system elements influencing the spread of a new idea (Elihu Katz et al., 1963; Rogers, 2002). The innovation could be an idea, technology, product, or programme new to the adopting

unit. Diffusion is the channel through which an innovation is communicated to members of a social system (Rogers, 2002). At the introduction of an innovation, several factors influence the innovation diffusion process that impacts an adopters' perception of the technology. This includes relative advantage (RA), defined as, the extent to which an innovation is perceived as an improvement to the idea it is replacing, and compatibility, defined as the extent to which an innovation is presumed to be consistent with the needs and existing values and past experiences of potential adopters. Other factors include complexity which is defined as the extent to which an innovation is presumed to be comparatively difficult to comprehend and use; trialability is the rate at which an innovation is experimented with on a limited basis, while observability is the extent to which the outcome of an innovation is noticeable to others. The adoption rate of innovation is faster as more individuals create and share information with common understanding.

3.2.2 Theory of Reasoned Action (TRA)

TRA describes technology acceptance and the ability to estimate and describe a wide range of human behaviour by predicting or explaining the actual behaviour of a person when faced with new options of action (Fishbein, 1980; Fishbein, 2008). It posits that an individual's actual behaviour is determined by their beliefs and prior intention, known as behavioural intention (BI) towards the given behavior which is a major predictor of behaviour. The two factors responsible for the BI of a person to performing a given behaviour are attitudes toward that behaviour and subjective norm (Alshammari and Rosli, 2020; Chuttur, 2009; Fishbein, 2008; Madden et al., 1992).

Figure 3.1 shows that attitude is derived from an individual's beliefs and evaluations of objects towards a given behaviour. This behaviour is affective and based upon a set of beliefs about the object of behaviour (Fishbein and Ajzen, 1975; Madden et al., 1992). Also, motivation and normative beliefs influence subjective norms which is what an individual perceives as their immediate society's attitude to a certain behaviour (such as using a car as a status with my colleagues). At the same time, a person's normative beliefs and subjective norms results from external people's influence on our actual behaviour (Lai, 2017). Furthermore, a person's belief is the strength of opinion towards a behaviour, the inner drive to pursue an endeavour (Fishbein, 2008; Lai, 2017). Attitude suggests an individual's positive or negative assessment of a given behaviour (Ajzen, 1991).

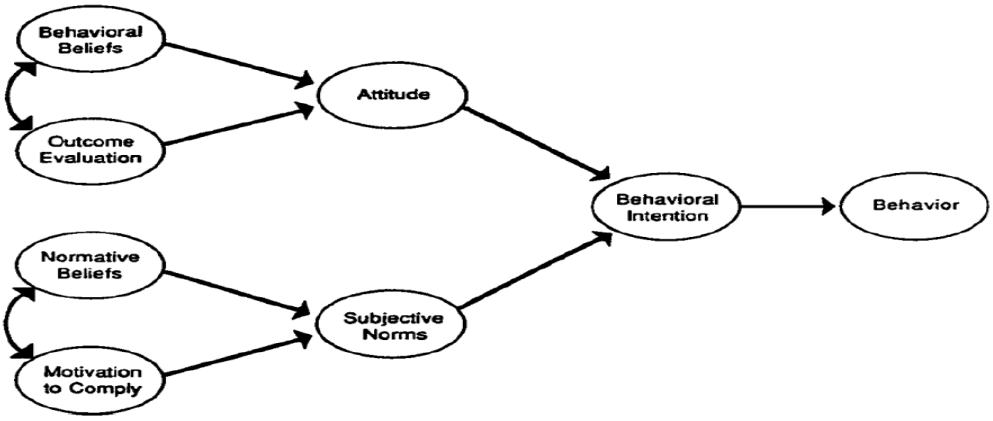

Figure 3-1: Theory of Reasoned Action (Fishbein and Ajzen, 1975)

3.2.3 Theory of Planned Behaviour (TPB)

The theory was developed by adding the Perceived Behavioural Control (PBC) construct to TRA, to describe situations where people do not have full control over their behaviour (Ajzen, 1991; Alshammari and Rosli, 2020; Chuttur, 2009). Figure 3.2 describes the subjective norm, attitude toward behaviour, and PBC factors influencing an individual's intention to perform a certain behaviour. PBC is defined as a person's perceived ability and limitations to perform a given behaviour which may vary in terms of situations and actions (Ajzen, 1991; Lai, 2017; Yucel and Gulbahar, 2013). Furthermore, TPB affirms that behaviour is a function of BI and PBC. But BI is shaped by one's attitude which reflects the positive or negative feelings towards the performance of a behaviour. PBC and subjective norm (SN) reflect an individual's desire to perform or not perform a behaviour (Taylor and Todd, 1995).

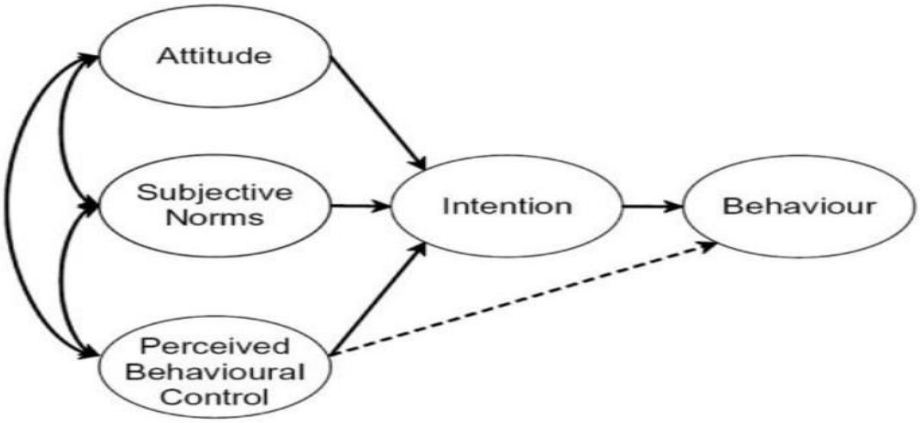

Figure 3-2: Theory of Planned Behaviour (Ajzen, 1991)

3.2.4 Decomposed Theory of Planned Behaviour (DTBP)

DTBP in theory is an improvement in overcoming some of the limits of TPB. It comprises of subjective norms, attitude, and perceived behaviour control, which affects BI and actual behaviour adoption (Lai, 2017; Taylor and Todd, 1995). Taylor and Todd (1995) decomposed the normative, attitudinal, and control belief of TPB into numerous ideas to offer an exciting and precise understanding of the antecedents of behaviour presented as firstly, clarity in the association between belief and the antecedents of intention, and secondly, a constant set of beliefs applied across various settings; and lastly, managerial relevance when concentrating on specific beliefs. This provides a better understanding of IT usage due to many factors that influence adoption and usage (Suryaningrum, 2012).

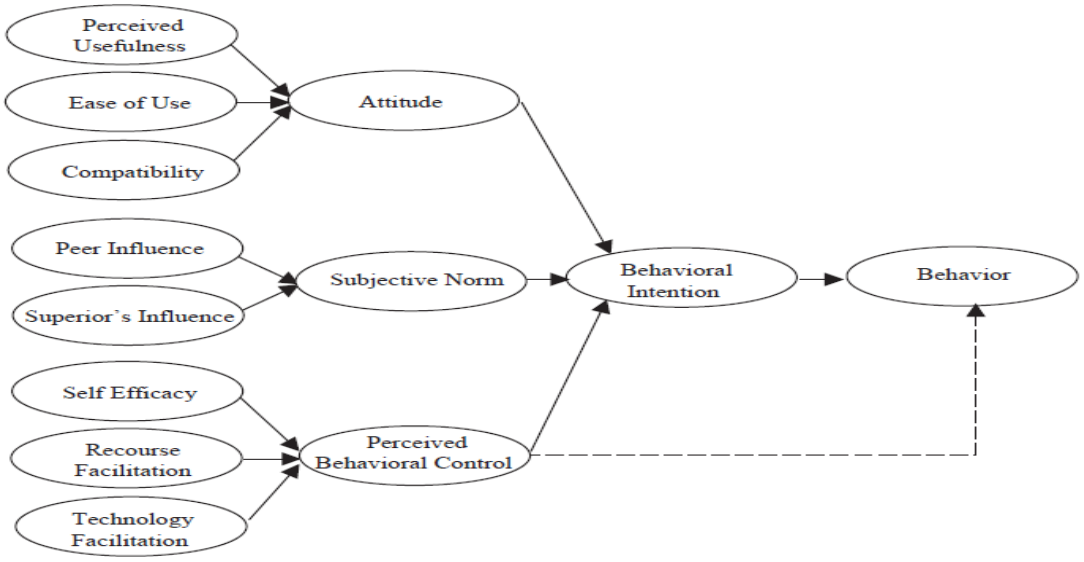

Figure 3-3: Decomposed Theory of Planned Behaviour (Teo & Pok, 2003)

3.2.5 Technology Acceptance Model (TAM)

TAM was introduced by Davis (1989) to specially personalise and describe individuals' potential users' BI to accept or try new technological innovation across a variety of computing technologies (Yucel and Gulbahar, 2013). Technology acceptance is determined by perceived usefulness (PU) and perceived ease of use (PEOU) which are predictors of information technology acceptance. PU is the degree to which an individual has confidence that the usage of a system will improve their performance while PEOU is the degree to which an individual believes that using a given application is free of effort (Alshammari and Rosli, 2020; Lai, 2017; Yucel and Gulbahar, 2013).

TAM has strong behavioural elements that assume that an individual will act freely without limitation when an intention to act is formed, despite several constraints in the real world to limit the freedom to act such as time constraints, limited ability, unconscious habits, environmental and organisational limits (Bagozzi, 2007; Bagozzi et al., 1992). TAM evolved over the years with the final version developed in 1996 where Venkatesh and Davis (1996) replaced the attitude variable with the BI when they found that both PU and PEOU directly influence BI. Furthermore, PU, PEOU, and BI are considered internal variables internal to the user since they describe the user's beliefs instead of external variables that are intended to describe everything except the user's beliefs (Yousafzai et al., 2007). However, with the evolution of TAM, new external variables are introduced, which impact BI, PEOU, PU, actual use, and behaviour. Variables mostly referenced are experience, compatibility, enjoyment, computing support, computer anxiety, and system quality (Lee et al., 2003). Besides, the linkage between the four major variables within the TAM model (PU, PEOU, BI and behaviour B) is predicted as using PU as both a dependent variable directly impacting BI and an independent variable because it is predicted by PEOU. Moreover, actual use and behaviour are commonly measured through the amount of time used, the frequency of utilisation, the actual number of usages, and usage variety.

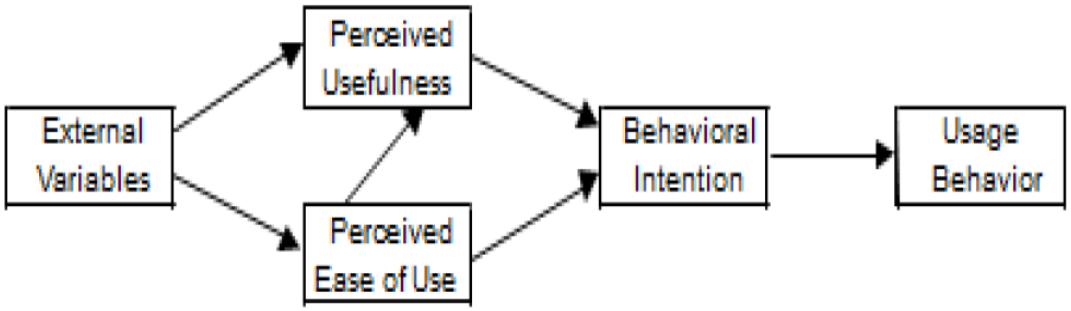

Figure 3-4: Technology Acceptance Model (TAM) (Venkatesh & Davis, 1996)

3.2.6 Extended Technology Acceptance Model (TAM 2)

Despite the simplicity and acceptance of TAM, TAM 2 added the determining factors of PU and usage intention to address TAM's limitations (Alshammari and Rosli, 2020; Lai, 2017; Venkatesh and Davis, 2000). External factors affecting PU are classified into two groups: social influence and cognitive instrumental processes. Social influence processes are subjective norms, imagination, and voluntariness. Cognitive instrumental processes are job relevance, output quality, result demonstrability and PEOU. TAM2 combined social influences into an individual's

perceptions of usefulness (Venkatesh and Davis, 2000). SN is an individual's desire to perform or not perform a behaviour (Taylor and Todd, 1995). Compared to subjective norm, image defines people's attitude and the way they want to be seen (Karahanna et al., 1999; Siu-cheung and Ming-te, 2004; Venkatesh and Davis, 2000). In conclusion, TAM 2 includes other variables that enhance its illustrative power, but at most times explains low percentages of a system's use (Lu et al., 2005).

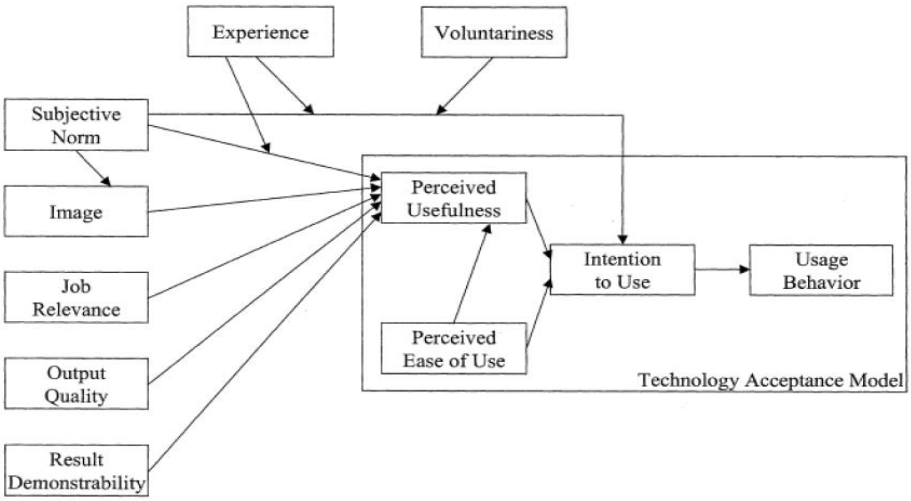

Figure 3-5: Technology Acceptance Model (TAM2) (Venkatesh & Davis, 2000)

3.2.7 Augmented TAM or Combined TAM and TPB (C-TAMTPB)

The theory was introduced by Taylor and Todd (1995) by adding SN and PBC to TAM. The aim was to eliminate TAM and TAM 2's limitations which excludes social and control factors influences on behaviour as SN and PBC were found to have a substantial impact on IT usage behaviour (Mathieson, 1991; Moore and Benbasat, 1991; Taylor and Todd, 1995). Deductively, these factors are also a key element of behaviour in TPB (Ajzen, 1991). C-TAMPPB is a broader test of the determinants of IT usage because of its predictive value in IT usage research (Taylor and Todd, 1995). Augmented TAM presents a suitable model of IT usage for inexperienced and experienced users accounting for a reasonable difference in intention and behaviour (Taylor and Todd, 1995). Hence, the augmented TAM can be used to predict successive usage behaviour of users having prior and no knowledge of the technology before valid conclusions are reached.

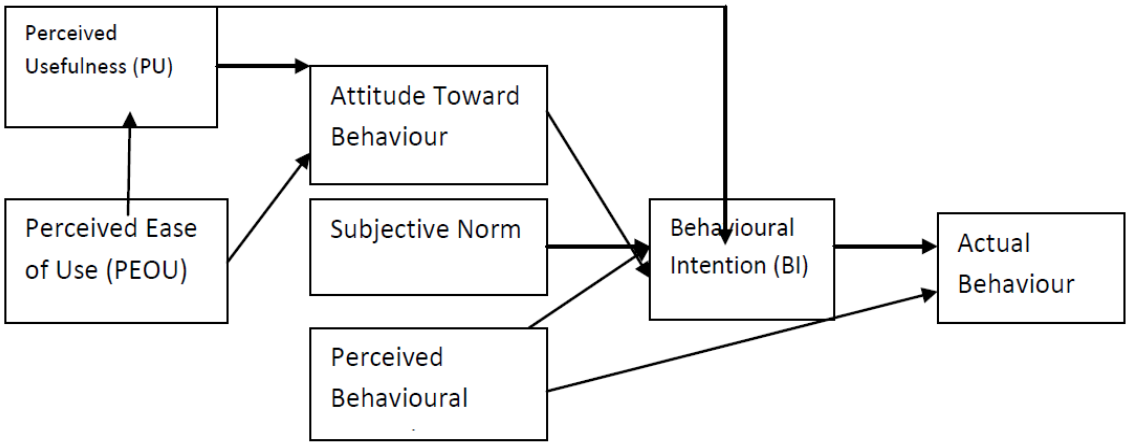

Figure 3-6: Augmented TAM/C-TAM-TPB adopted from Taylor & Todd, (1995)

3.2.8 Integrated TAM (TAM 3)

Integrated TAM 3 was developed by integrating TAM 2 and the determining factors of PU and PEOU. Integrated TAM 3 includes system characteristics, individual differences, facilitating conditions, and social influence (Venkatesh and Bala, 2008; Venkatesh and Davis, 2000). In the TAM 3 research model in Figure 3.7, the PEOU to PU, computer anxiety to PEOU and PEOU to BI are moderated by experiences tested in real-life settings of IT implementations.

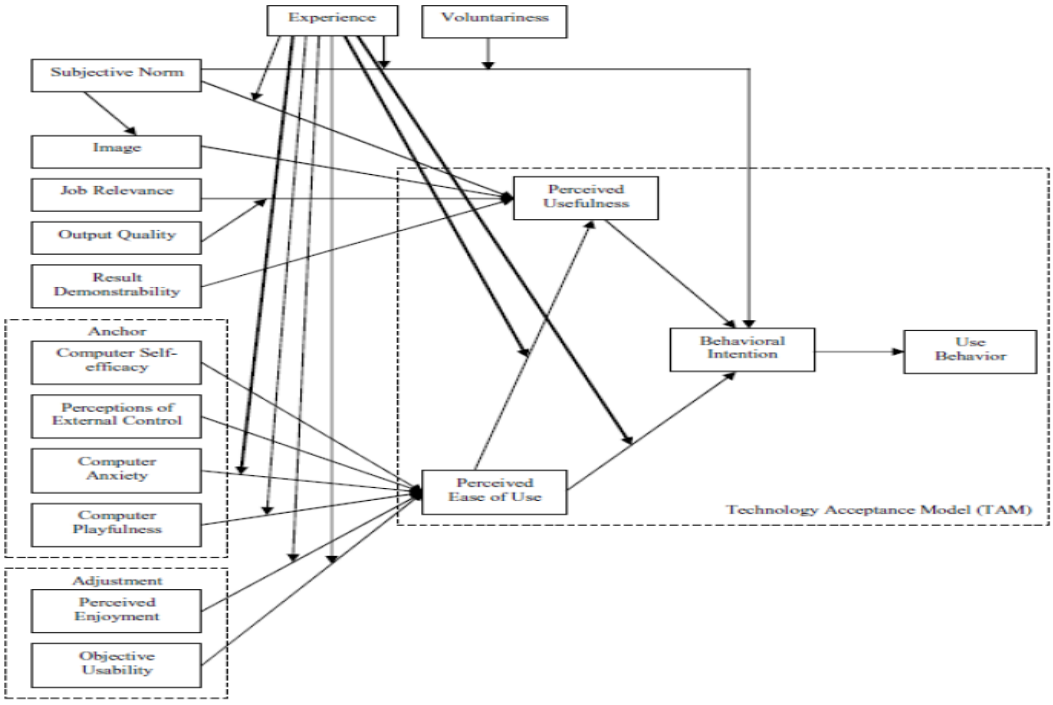

Figure 3-7: Technology Acceptance Model (TAM3) (Venkatesh & Bala 2008)

3.2.9 Technology, Organisation, and Environment Framework

TOE was developed by Tornatzky et al. (1990) to explain the adoption of technological innovations at organisational level. They posit that technological innovations adoption is influenced by three organisational contexts: the technological, organisational, and environmental (TOE) context (see Figure 3.8). The technological context refers to the types of technologies used by an organisation for its internal operations and its interactions with external entities. The organisational context refers to the corporate identity of vision, mission, policies, practices, managerial structure, size, and core business. The environmental context refers to the setting in which an organisation conducts its affairs: What industry is the organisation a part of? Who are its competitors? What are some of its dealings? These impact on a firm's adoption process of technological innovation with technology separated from organisation and environment to show how its features can influence a firm to adopt the technology (Jere and Ngidi, 2020; Tornatzky et al., 1990). However, the TOE framework did not specifically discuss the characteristics or features of technology as compared to DOI theory (Rogers, 2002).

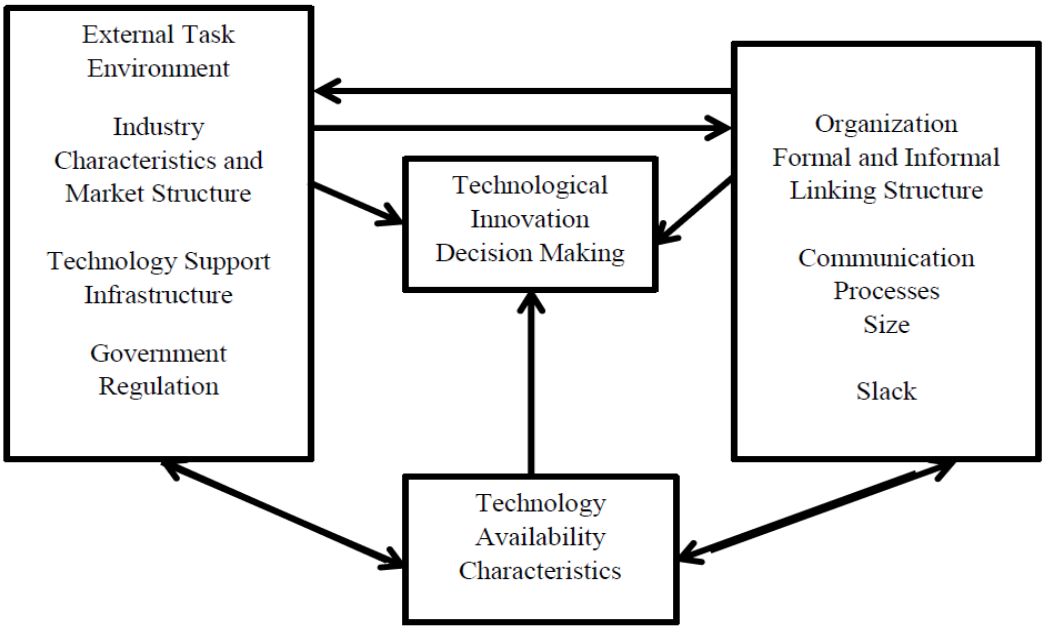

Figure 3-8: TOE Framework (Tornatzky et al., 1990)

3.2.10 The Unified Theory of Acceptance and Use of Technology (UTAUT)

Venkatesh et al. (2003) combined eight theories and models to form the UTAUT to identify user BI using a variety of independent variables such as age, gender, voluntariness of use, and experience. The other variables are PE, EE, SI, and FC. These variables are believed to influence

user acceptance and usage (Alshammari and Rosli, 2020; Lai, 2017). The combinations of the constructs and moderating factors increase the predictive efficiency of UTAUT by 70%, which is a major improvement over the previous TAM model that explains 40% of users' acceptance of the technology (Oye et al., 2012).

UTAUT consists of four predictors of users' BI which are PE, EE, SI, and FC as displayed in Figure 3.9. Performance expectancy is an individual's beliefs that the use of technologies results in better performance outcomes. Performance expectancy construct in the UTAUT model includes the PU, RA, job-fit, extrinsic motivation, and outcome expectation. Effort Expectancy is the ease of using technologies. EE explains the idea of PEOU and complexity. Social factors refer to the extent to which an individual believes that other people should use the technologies. As for the social context, Venkatesh et al. (2003) validation tests found that SI was not significant in voluntary contexts and that PE, EE, SI and FC are directly associated with BI to use a technology that consequently affect a user's decision to adopt a technology. This intention has been found to be a driving factor toward individual's actual behaviour as deliberated in the Theory of Reasoned Action (Taylor and Todd, 1995). Facilitating Conditions is the degree to which the technical and organisational infrastructure required to support the technologies exists.

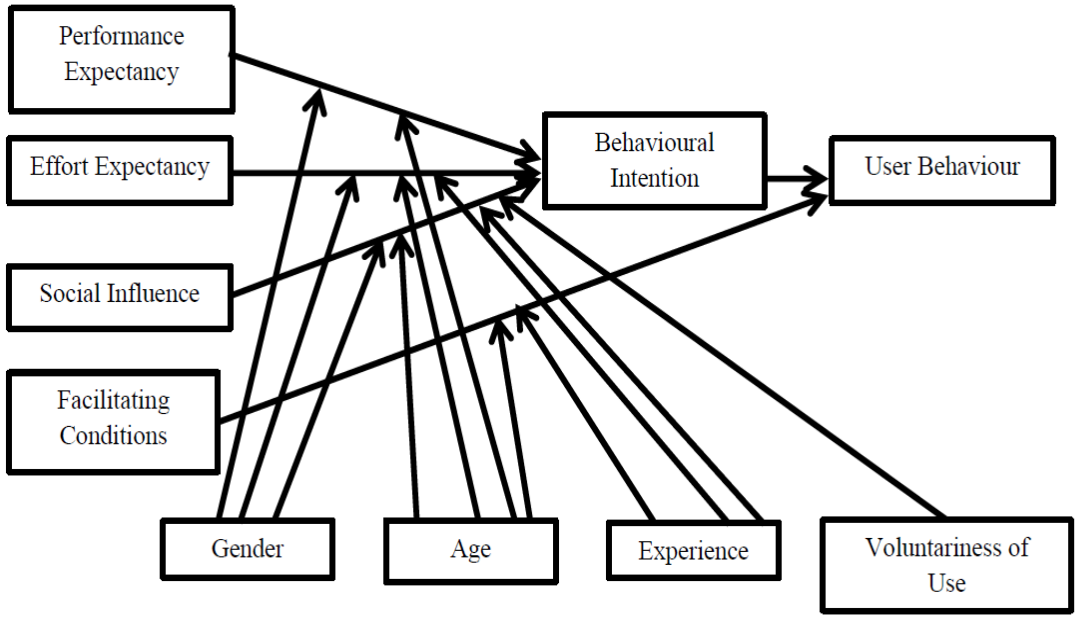

Figure 3-9: Unified Theory of Acceptance and Use of Technology (Venkatesh et al. 2003)

3.3 Summarised Comparative Analysis of the Model

By drawing on the review of technology adoption theories above, the following constructs were identified.

Table 3-1: Summary of construct from the reviewed theoretical framework

Theory	**Core Constructs**
TAM	Perceived usefulness, perceived ease of use
TPB	Perceived behavioural control, subjective norm, and attitude toward behaviour
DTBP	Decomposition of belief, relationship between belief and the antecedents of intention
TAM2	Social influence processes (voluntaries, subjective norm, image, and experience)
	Cognitive instrumental processes (output quality, job relevance, and result demonstrability)
Augmented TAM	Influence of social and control factors on behaviour (subjective norm and perceived behavioural control)
TRA	Behavioural intentions, attitude
	Subjective norm
DOI	Relative advantage, compatibility, ease of use, image, visibility, compatibility, result demonstrability, voluntariness of use
UTAUT	Performance expectancy, effort expectancy, social influence, facilitating condition, behavioural intention
	Moderating factors (age experience, voluntariness)
TOE	Technology context (availability, internal and external characteristics)
	Environmental context (regulations, technical support infrastructure)
	Industry characteristics and market structure
	Organisational context (linking structures, communication processes, size)

Source: Author's compilation 2022

3.4 Determinant Factors underpinning the Study

Consistent with the research objectives and the outcome of the above review, this section draws on the discussion of the previous two sections to identify factors to be used for the conceptual hackathon framework, by implication, developing a hackathon conceptual framework that considers constructs from the various technology adoption theories. Reviewing the identified studies on "technology adoption" would mostly reveal significant factors that predict technology

adoption. Moreover, the identified factors would guide the study and future researchers to create models for adoption and innovation when conducting their studies.

The systematic review method used in section 2.2 was adopted to fulfil the objectives of developing the integrative conceptual framework. Keywords such ‘Technology Adoption as a Review’, ‘Technology Adoption in Education’, ‘Technology Adoption Related Studies’ were used. The IEEE, EBSCOhost, and Google Scholar database were used to cover an extensive search where one hundred and twenty papers were found which are further examined in the subsequent sections to arrive at the final factors used for the conceptual hackathon framework.

3.4.1 Article Selection

Selection of articles began with an initial review by checking and eliminating duplicates of literatures which did not fit into the context of the study. The bibliography of the remaining articles was checked for eligible articles, a method known as snowballing. Eighty articles that fit the scope of the study and selection criteria were listed according to their citation: author name, publication date, article name, type of adoption model. Data obtained from the reviewed literature were entered into Microsoft Excel using the construct, author name, frequency of the construct in the reviewed literature, level of significance and non-significance of the identified construct to extract our information.

Content analysis is applied to derive themes that would explain the collected data by bringing together similar data within a framework of certain factors. The factors were interpreted and arranged in a way that readers can understand through the systematic classification process of coding and identifying themes or patterns (Hsieh and Shannon, 2005; Zhang and Wildemuth, 2009).

Once the constructs were identified, a table was created listing the constructs based on their significance, non-significance, and observed frequencies (Table 3.2 refers). Closely related factors or those with similar definitions were grouped with a new name. Frequencies for the new groups were observed before sorting them according to their level of significance to arrive at the new list of factors. Numerical conversion was done on the newly listed factors based on the ratio of the significant variables to their frequency. Finally, the mostly significant average weight was determined to arrive at the choice of selection of a value of 0.8 and above. Finally, the obtained findings were interpreted.

3.4.2 Applied Selection Criteria

- Study that explores factors influencing technology adoption.

- Significant and non-significant constructs from the reviewed literatures.
- Constructs used in similar instruments or questionnaire are grouped as one factor. For instance, behavioural intention, intention to use, intention to play are grouped as behavioural intention.
- Constructs with no significance or a value of 0.0 regardless of their frequency in literature are measured.
- Constructs with one significance regardless of their frequency in literature were measured.
- Constructs with two and three significances regardless of their frequency in literature were measured.
- Constructs with a value greater than or equal to 0.8 using the total values of significant constructs over the total frequency of constructs in reviewed literature were used as factors for the hackathon conceptual model.

However, in attempting to address the objective of the study, it is necessary to start with a definition of the terms defined within the context of research which applies to the headings in Tables 3.2 – 3.6 and the remainder of the study.

- Constructs: A characteristic, or a quantity of a phenomenon that is measured or classified from the reviewed literature.
- Frequency: The number of times the variable was identified and tested in the identified reviewed literature.
- Significance: The number of times in reviewed studies that the variable was found significant or proven to be valid indicating that the researchers' results are unlikely the result of chance.
- Non-significance: The number of times in reviewed studies that the variable was found not significant.
- Variable effect: The value of our significance per frequency for each identified variable.

Table 3-2: Identified factors and their frequency per variable effect

Constructs	Related Studies	Frequency	Significance	Non-significance	Variable Effect
Perceived Ease of Use	(Abramson et al., 2015; Alambaigi and Ahangari, 2016; Al-Azawei and Lundqvist, 2015; Al-Azawei et al., 2017; Al-hawari and Mouakket, 2010; Baharin et al., 2015; Beldad and Hegner, 2018; Bresciani and Eppler, 2015; Chang et al., 2012; Chen et al., 2017; Diop et al., 2019; Dumpit and Fernandez, 2017; Fathema et al., 2015; Gagnon et al., 2012; Ghane et al., 2011; Godoe and Johansen, 2012; Gupta et al., 2008; He et al., 2018; Hsu and Lu, 2004; Julianto and Yasa, 2019; Lee et al., 2001; Lu et al., 2010; Lu et al., 2005; Maduku, 2014; Nassuora, 2013; Park et al., 2013; Sánchez and Hueros, 2010; Shah Alam et al., 2011; Šumak et al., 2011; Teo and Pok, 2003; Van Slyke et al., 2004; Van Slyke et al., 2005; Weng et al., 2018)	27	22	5	0.8
Social Influence	(AbuShanab and Pearson, 2007; Alalwan et al., 2018; Al-Qeisi et al., 2015; Alrawabdeh, 2014; Alshehri et al., 2012; Amadin and Obienu, 2016; Attuquayefio and Addo, 2014; Chen et al., 2017; Dadayan and Ferro, 2005; Ghane et al., 2011; Giannakos and Vlamos, 2013; Gupta et al., 2008; Hsu and Lu, 2004; Ibrahim et al., 2018; Kijsanayotin et al., 2009; Lu et al., 2010; Lu et al., 2005; Maduku,	25	15	10	0.6

	2015; Minh et al., 2017; Moghavvemi et al., 2012; Mosweu and Bwalya, 2018; Muriithi et al., 2016; Park et al., 2013; Rahi and Ghani, 2018; Zahir and Gharleghi, 2015)				
Performance Expectancy	(AbuShanab and Pearson, 2007; Alalwan et al., 2018; Al-Qeisi et al., 2015; Alshehri et al., 2012; Alsheikh and Bojei, 2014; Amadin and Obienu, 2016; Attuquayefio and Addo, 2014; Dadayan and Ferro, 2005; Giannakos and Vlamos, 2013; Gupta et al., 2008; Ibrahim et al., 2018; Kijsanayotin et al., 2009; Maduku, 2015; Moghavvemi et al., 2012; Mosweu and Bwalya, 2018; Muriithi et al., 2016; Rahi and Ghani, 2018; Rahi et al., 2018; Zahir and Gharleghi, 2015)	16	13	4	0.8
Perceived Usefulness	(Abramson et al., 2015; Alambaigi and Ahangari, 2016; Al-Azawei and Lundqvist, 2015; Al-Azawei et al., 2017; Al-hawari and Mouakket, 2010; Baharin et al., 2015; Bresciani and Eppler, 2015; Chang et al., 2012; Chen et al., 2017; Diop et al., 2019; Dumpit and Fernandez, 2017; Fathema et al., 2015; Gagnon et al., 2012; Godoe and Johansen, 2012; Horton et al., 2018; Hsu and Lu, 2004; Julianto and Yasa, 2019; Lu et al., 2010; Maduku, 2014; Nassuora, 2013; Park et al., 2013; Sánchez and Hueros, 2010; Šumak et al., 2011;	19	17	2	0.9

	Wang et al., 2011; Weng et al., 2018; Zhang et al., 2008)				
Effort Expectancy	(AbuShanab and Pearson, 2007; Alalwan et al., 2018; Al-Qeisi et al., 2015; Alshehri et al., 2012; Alsheikh and Bojei, 2014; Amadin and Obienu, 2016; Attuquayefio and Addo, 2014; Dadayan and Ferro, 2005; Giannakos and Vlamos, 2013; Gupta et al., 2008; Ibrahim et al., 2018; Kijsanayotin et al., 2009; Maduku, 2015; Moghavvemi et al., 2012; Mosweu and Bwalya, 2018; Muriithi et al., 2016; Rahi and Ghani, 2018; Rahi et al., 2018; Zahir and Gharleghi, 2015)	19	14	5	0.7
Behavioural Intention to Use	(Alalwan et al., 2018; Alambaigi and Ahangari, 2016; Al-Qeisi et al., 2015; Alsheikh and Bojei, 2014; Attuquayefio and Addo, 2014; Baharin et al., 2015; Chen et al., 2017; Diop et al., 2019; Dumpit and Fernandez, 2017; Fathema et al., 2015; Gupta et al., 2008; Horton et al., 2001; Hsu and Lu, 2004; Ibrahim et al., 2018; Isiyaku et al., 2015; Kijsanayotin et al., 2009; Liao et al., 1999; Lu et al., 2010; Maduku, 2014; Maduku, 2015; Moghavvemi et al., 2012; Mosweu and Bwalya, 2018; Parker et al., 1992; Rahi et al., 2018; Rahi and Ghani, 2018; Šumak et al., 2011; Teo and Pok, 2003; Van den Berg and Van der Lingen, 2019; Van Slyke et al., 2010; Wang et al.,	17	15	2	0.9

	2011; Weng et al., 2018; Zhang et al., 2008)				
Facilitating Conditions	(Alalwan et al., 2018; Alshehri et al., 2012; Amadin and Obienu, 2016; Attuquayefio and Addo, 2014; Dadayan and Ferro, 2005; Fathema et al., 2015; Gagnon et al., 2012; Gupta et al., 2008; Ibrahim et al., 2018; Kijsanayotin et al., 2009; Maduku, 2015; Moghavvemi et al., 2012; Mosweu and Bwalya, 2018; Muriithi et al., 2016; Rahi et al., 2018; Zahir and Gharleghi, 2015)	15	13	2	0.9
Attitude Towards Use	(Abramson et al., 2015; Al-Azawei et al., 2017; Amadin and Obienu, 2016; Chang et al., 2012; Chen et al., 2017; Diop et al., 2019; Fathema et al., 2015; Gagnon et al., 2012; Hsu and Lu, 2004; Isiyaku et al., 2015; Julianto and Yasa, 2019; Liao et al., 1999; Lu et al., 2010; Maduku, 2014; Minh et al., 2017; Parker et al., 1992; Sánchez and Hueros, 2010, Šumak et al., 2011; Teo and Pok, 2003; Weng et al., 2018)	13	12	1	0.9
Trust	(Beldad and Hegner, 2018; Chong et al., 2009; Maduku, 2014; Nassuora, 2013; Van Slyke et al., 2004; Van Slyke et al., 2005; Van Slyke et al., 2010; Zahir and Gharleghi, 2015)	9	2	7	0.2
Subjective Norm	(Abramson et al., 2015; Dumpit and Fernandez, 2017; Gagnon et al., 2012; Liao et al., 1999; Lu et al., 2010; Maduku, 2014; Parker et al.,	8	6	2	0.8

	1992; Tan and Teo, 2000; Teo and Pok, 2003)				
Relative Advantage	(Alshamaila et al., 2013; Chiu et al., 2017; Chong et al., 2009; Chong and Bauer, 2000; Ghane et al., 2011; Hussin and Noor, 2005; Lee et al., 2001; Ramdani et al., 2009; Shah Alam et al., 2011; Tan and Eze, 2008; Tan and Teo, 2000; Teo and Pok, 2003; Thong, 1999; Van Slyke et al., 2004; Van Slyke et al., 2005; Van Slyke et al., 2010; Wang et al., 2011; Zhu et al., 2006)	7	6	1	0.9
Self-efficacy	(Abramson et al., 2015; Al-Azawei and Lundqvist, 2015; Fathema et al., 2015; Giannakos and Vlamos, 2013; He et al., 2018; Lee et al., 2001; Maduku, 2014; Sánchez and Hueros, 2010; Tan and Teo, 2000; Teo and Pok, 2003)	7	6	1	0.9
Perceived Enjoyment	(Al-hawari and Mouakket, 2010; Chen et al., 2017; Isiyaku et al., 2015; Zhang et al., 2008)	6	4	2	0.7
Security	(Shah Alam et al., 2011; Tan and Teo, 2000; Zhu et al., 2006)	4	3	1	0.8
Cost	(Alsheikh and Bojei, 2014; Daniel and Grimshaw, 2002; Kuan and Chau, 2001; Lee et al., 2001; Nassuora, 2013; Shah Alam et al., 2011; Tan and Eze, 2008; Tu, 2018; Zhu et al., 2006; Zhu and Kraemer, 2005)	4	2	2	0.5
Perceived Behavioural Control	(Giannakos and Vlamos, 2013; Liao et al., 1999; Lu et al., 2010; Teo and Pok, 2003)	4	2	2	0.5

Perceived Benefits	(Aghaunor and Fotoh, 2006; Kuan and Chau, 2001; Oliveira and Martins, 2010; Tu, 2018)	4	1	3	0.3
Complexity	(Aghaunor and Fotoh, 2006; Chiu et al., 2017; Chong et al., 2009; Chong and Bauer, 2000; Hussin and Noor, 2005; Ramdani et al., 2009; Tan and Eze, 2008; Tan and Teo, 2000; Thong, 1999; Van Slyke et al., 2004)	3	3	0	1.0
Perceived Risk	(Alalwan et al., 2018; Alsheikh and Bojei, 2014; Nasri, 2011; Tan and Teo, 2000; Teo and Pok, 2003)	5	2	1	0.4
Hedonic Motivation	(Alalwan et al., 2018; Amadin and Obienu, 2016; Rahi and Ghani, 2018)	3	2	1	0.7
Top Management Support	(Aghaunor and Fotoh, 2006; Alshamaila et al., 2013; Chiu et al., 2017; Chong et al., 2009; Chong and Bauer, 2000; Hussin and Noor, 2005; Ramdani et al., 2009)	7	1	2	0.1
Habit	(Alalwan et al., 2018; Amadin and Obienu, 2016; Gagnon et al., 2012; Rahi et al., 2018)	4	1	2	0.3
Prior Experience	(Abramson et al., 2015; Alambaigi and Ahangari, 2016; Alshamaila et al., 2013; Alsheikh and Bojei, 2014; Nasri, 2011; Tan and Teo, 2000)	6	2	0	0.3
Observability	(Chiu et al., 2017; Ghane et al., 2011; Hussin and Noor; 2005; Ramdani et al., 2009; Tan and Eze, 2008)	5	2		0.4

Market Scope/E-readiness	(Aghaunor and Fotoh, 2006; Alshamaila et al., 2013; Ramdani et al., 2009)	3	2		0.7
Voluntariness	(Kijsanayotin et al., 2009; Van den Berg and Van der Lingen, 2019; Van Slyke et al., 2004)	3	2		0.7
Actual Behaviour, Organisational Culture, Perceived Technology Security, Job relevance	(Alambaigi and Ahangari, 2016; Al-Azawei et al., 2017; Chong and Bauer, 2000; Lu et al., 2010; Rahi et al., 2018; Rahi and Ghani, 2018; Van Slyke et al., 2010)	2	2		1.0
Innovativeness	(Alshamaila et al., 2013; Godoe and Johansen, 2012; Lee et al., 2001; Lu et al., 2005; Park et al., 2013; Rahi and Ghani, 2018; Thong, 1999)	7	1	1	0.1
Result demonstrability	(Van Slyke et al., 2004; Van Slyke et al., 2005; Van Slyke et al., 2010)	3	1	1	0.3
Actual Use, Information Quality, Price Value	(Alalwan et al., 2018; Diop et al., 2019; Fathema et al., 2015; Julianto and Yasa, 2019; Minh et al., 2017; Rahi et al., 2018)	2	1	1	0.5

3.4.3 Result

One hundred and fifty-three variables were identified from the review using the above selection criteria. The following steps were taken to arrive at the final list of constructs to be used as the proposed conceptual model of hackathon adoption. Eighty-two variables with either zero significance or variable effect of zero were grouped and removed from the total list of variables leaving the study with seventy-two variables (Table 3.3 refers).

Table 3-3: Factors with zero frequency significance

Author	Constructs
(Aghaunor and Fotoh, 2006; Alrawabdeh, 2014; Alshamaila et al., 2013; Chiu et al., 2017; Chong et al., 2009; Chong and Bauer, 2000; Daniel and Grimshaw, 2002; Ghane et al., 2011; Hussin and Noor, 2005; Kijsanayotin et al., 2009; Kuan and Chau, 2001; Lee et al., 2001; Oliveira and Martins, 2010; Ramdani et al., 2009; Shah Alam et al., 2011; Tan and Eze, 2008; Tan and Teo, 2000; Teo and Pok, 2003; Thong, 1999; Van Slyke et al., 2004; Zhu et al., 2006; Zhu et al., 2003; Zhu and Kraemer, 2005)	awareness of mobile banking services flow experience, intention, intention to recommend, support.

Of the seventy-two constructs, the study grouped constructs with one significance regardless of its frequency in the study leading to the removal of forty-four variables and leaving the study with twenty-seven variables. Furthermore, the study grouped variables with two and three significances regardless of their frequency in the reviewed literature shown in Table 3.4 allowing the study to group and remove fifteen factors leaving the study with twelve factors as presented in Table 3.5.

Table 3-4: Factors with two and three frequency significance

Authors	Constructs
(Abramson et al., 2015; Aghaunor and Fotoh, 2006; Alalwan et al., 2018; Alambaigi and Ahangari, 2016; Al-Azawei and Lundqvist, 2015; Alshamaila et al., 2013; Alsheikh and Bojei, 2014; Amadin and Obienu, 2016; Beldad and Hegner, 2018; Chiu et al., 2017; Chong et al., 2009; Chong and Bauer, 2000; Daniel and Grimshaw, 2002; Ghane et al., 2011; Giannakos and Vlamos, 2013; Hussin and Noor, 2005; Kijsanayotin et al., 2009; Kuan and Chau, 2001; Lee et al., 2001; Liao et al., 1999; Lu et al., 2010; Maduku, 2014; Nasri, 2011; Nassuora, 2013; Rahi and Ghani, 2018; Rahi et al., 2018; Ramdani et al., 2009; Shah Alam et al., 2011; Tan and Eze, 2008; Tan and Teo, 2000; Teo and Pok, 2003; Thong, 1999; Tu, 2018; Van den Berg and Van der Lingen, 2019; Van Slyke et al., 2004; Van Slyke et al., 2005; Van Slyke et al., 2010; Zahir and Gharleghi, 2015; Zhu et al., 2006; Zhu and Kraemer, 2005)	Trust, cost, perceived behavioural control, perceived risk, hedonic motivation, prior experience, observability, market scope/e-readiness, voluntariness, organisational culture, perceived technology security, job relevance, complexity, security

Table 3-5: Factors with more than three significances

Constructs	Frequency	Significance	Non- Significance	Variable Effect
Perceived Ease of Use	27	22	5	0.8
Perceived Usefulness	19	17	2	0.9
Social Influence	25	15	10	0.6
Behavioural Intention to Use	17	15	2	0.9
Effort Expectancy	19	14	5	0.8
Performance Expectancy	16	13	3	0.8
Facilitating Conditions	15	13	2	0.9
Attitude towards Use	13	12	1	0.9
Subjective Norm	8	6	2	0.8
Relative Advantage	7	6	1	0.9
Self-Efficacy	7	6	1	0.9
Perceived Enjoyment	6	4	2	0.7

The constructs to be measured and tested for validation are given in Table 3.6. Factors with variable effect values of 0.8 and above are considered bringing together constructs to explain or predict the factors that influence the adoption of hackathon for teaching and learning of CP where the conceptual framework integrates these factors from literature review and field data as presented in Figure 3.10.

Table 3-6: Core factors of conceptual hackathon adoption framework

Constructs	Frequency	Significance	Non-significance	Variable Effect
Perceived Ease of Use	33	22	5	0.8
Perceived Usefulness	27	17	2	0.9
Performance Expectancy	19	17	4	0.8
Behavioural Intention to Use	33	15	2	0.9
Facilitating Conditions	16	13	2	0.9

Attitude Towards Use	20	12	1	0.9
Relative Advantage	18	6	1	0.9
Self-Efficacy	9	6	1	0.9
Subjective Norm	9	6	2	0.8
Effort Expectancy	19	16	5	0.8

3.5 Conceptual Framework and Hypotheses

The research aims to investigate the factors and develop a framework for hackathon adoption. The study is of the opinion that one theory or model cannot meaningfully explain the research problem. The proposed hackathon conceptual framework integrates constructs from several technology adoption models and frameworks discussed above. These constructs have been empirically tested in prior studies and adapted for questionnaire development in this study. The hackathon conceptual framework serves as a guide for data collection, and analysis, and establishes a complete framework of the factors that influence hackathon adoption.

The motivation for the research was to (i) test the relationships between the factors that influence hackathon adoption and (ii) investigate the factors that influence hackathon adoption from the identified constructs in Table 3.6. The findings will extend empirical research hackathon adoption in HEI. Hence, the study proposes that perceived ease of use, perceived usefulness, performance expectancy, facilitating conditions, attitude towards use, relative advantage, self-efficacy, subjective norm, and effort expectancy all have a significant positive relationship and impact behavioural intention to adopt hackathons as diagrammatically displayed in Figure 3.10. The study has hypotheses for correlation and regression because it intends to investigate and find factors that had a bearing on hackathon adoption for teaching and learning computer programming as well as identify the factors that have a direct and significant effect on hackathon adoption.

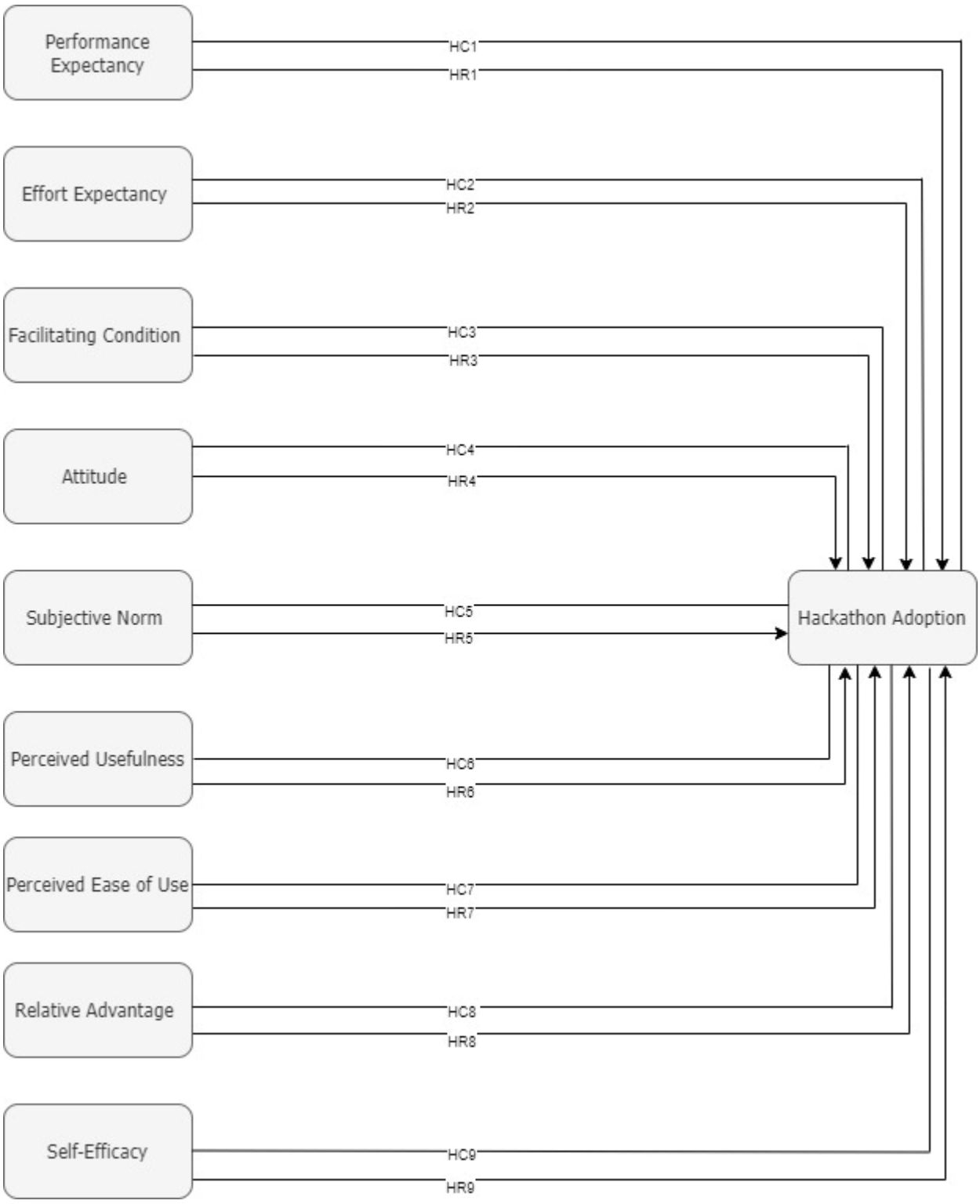

Figure 3-10: Proposed conceptual framework for hackathon adoption

The following subsections provide a description of each construct, along with the theoretical justification for including them in the conceptual model and the associated hypotheses.

3.5.1 Performance Expectancy

Performance expectancy is the extent to which an individual believes that the use of technologies will result in better performance outcomes (Venkatesh et al., 2013; Venkatesh et al., 2003). The PE constructs are drawn from different IS models such as perceived usefulness (TAM and combined TAM-TPB), relative advantage (DOI), and outcome expectancy (SCT). It is known as a strong predictor of behavioural intention towards technology and therefore there is a motivation to consider it (Davis, 1989; Venkatesh et al., 2003). In this research context, performance expectancy refers to the extent to which an individual believes that using a hackathon will help him or her to attain gains in learning outcomes. To explain performance expectancy towards hackathon adoption, the author proposed the following hypothesis:

Correlation Analysis:

H_{C0}: *Performance expectancy has no relationship with behavioural intentions to adopt hackathon*

H_{C1}: *Performance expectancy has a positive relationship with behavioural intentions to adopt hackathon*

Regression Analysis:

H_{R0}: *Performance expectancy has no positive influence on behavioural intentions to adopt hackathon*

H_{R1}: *Performance expectancy has a positive influence on behavioural intentions to adopt hackathon*

3.5.2 Effort Expectancy

Effort expectancy is the ease of using technologies (Venkatesh et al., 2003). Drawn from IS models such as perceived ease of use (TAM/TAM2), complexity (MPCU) and ease of use (IDT), it is known to be a strong predictor of behavioural intention towards technologies Venkatesh et al., 2003). In this research context, effort expectancy refers to the degree of ease associated with the use of a hackathon. Consequently, the following hypothesis was proposed.

Correlation Analysis:

H_{C0}: *Effort expectancy has no relationship with behavioural intentions to adopt hackathon*

H_{C2}: *Effort expectancy has a positive relationship with behavioural intentions to adopt hackathon*

Regression Analysis:

H_{R0}: *Effort expectancy has no positive influence on behavioural intentions to adopt hackathon*

H_{R2}: *Effort expectancy has a positive influence on behavioural intentions to adopt hackathon*

3.5.3 Facilitating Conditions

Facilitating conditions are the degree to which an individual believes the technical and organisational infrastructure required for the support of the technologies exists (Venkatesh et al., 2003). It is found to be a significant predictor of the technology use and its construct has a positive effect on innovation use (Chang et al., 2012; Moore and Benbasat, 1991; Taylor and Todd, 1995, Thompson et al., 1991; Venkatesh et al., 2003). Within this study, facilitating conditions were measured by the perception of being able to access required resources, as well as to obtain knowledge and the necessary support needed to adopt hackathon. To explain facilitating conditions toward behaviour of hackathon use, the researcher proposed the following hypothesis:

Correlation Analysis:

H_{C0}: *Facilitating conditions have no relationship with behavioural intentions to adopt a hackathon*

H_{C3}: *Facilitating conditions have a positive relationship with behavioural intentions to a adopt hackathon*

Regression Analysis:

$H_{R0:}$ *Facilitating conditions have no positive influence on behavioural intentions to adopt hackathon*

H_{R3}: *Facilitating conditions have a positive influence on behavioural intentions to adopt hackathon*

3.5.4 Attitude

Attitude towards behaviour is defined as an individual's positive or negative feelings (evaluative affect) about performing the target behaviour (Fishbein and Ajzen, 1975; Venkatesh et al., 2003). Adapted from TRA, it is one of the most fundamental and influential theories of human behaviour used to predict a wide range of behaviours. Davis et al. (1989) applied TRA to individual acceptance of technology and found that the variance explained was largely consistent with studies that had employed TRA in the context of other behaviours. In this research context, attitude refers to an individual's feeling (positive or negative) towards using a hackathon to attain

gains in learning outcomes. To explain attitude toward behaviour, the author proposed the following hypothesis:

Correlation Analysis:

H_{C0}: *Attitude has no relationship with behavioural intentions to adopt a hackathon*

H_{C4}: *Attitude has a positive relationship with behavioural intentions to adopt a hackathon*

Regression Analysis:

H_{R0}: *Attitude conditions have no positive influence on behavioural intentions to adopt a hackathon*

H_{R4}: *Attitude conditions have a positive influence on behavioural intentions to adopt a hackathon*

3.5.5 Subjective Norm

Subjective norm refers to the degree of a person's perception that most people who are important to him think he should or should not perform the behaviour in question (Ajzen, 1991; Davis et al., 1989; Fishbein and Ajzen, 1975; Mathieson, 1991; Taylor and Todd, 1995; Venkatesh and Bala, 2008). The construct is adapted from TRA/TPB. Ajzen (1991) presented a review of several studies that successfully used TPB to predict intention and behaviour in a wide variety of settings. TPB has been successfully applied to the understanding of individual acceptance and usage of many different technologies (Mathieson, 1991; Taylor and Todd, 1995). Within this study, subjective norm was measured by the perception of being able to validate the role of important people to accept or not accept hackathon use. Consequently, the following hypothesis was proposed.

Correlation Analysis:

H_{C0}: *Subjective norm has no relationship with behavioural intentions to adopt a hackathon*

H_{C5}: *Subjective norm has a positive relationship with behavioural intentions to adopt a hackathon*

Regression Analysis:

H_{R0}: *Subjective norm has no positive influence on behavioural intentions to adopt a hackathon*

H_{R5}: *Subjective norm has a positive influence on behavioural intentions to adopt a hackathon*

3.5.6 Perceived Usefulness

This is the degree to which a person believes that using a particular system would enhance his or her job performance (Davis, 1989). A construct adapted from TAM has been widely applied to a diverse set of technologies and users (Venkatesh et al., 2003). Tailored to IS contexts, TAM was designed to predict information technology acceptance and usage on the job and as well it is widely applied to a diverse set of technologies and users. Within this study, perceived usefulness refers to the degree to which an individual believes that the use of a hackathon will enhance his or her computer programming skills. Consequently, the following hypothesis was proposed:

Correlation Analysis:

H_{C0}: *Perceived usefulness has no relationship with behavioural intentions to adopt a hackathon*

H_{C6}: *Perceived usefulness has a positive relationship with behavioural intentions to adopt a hackathon*

Regression Analysis:

H_{R0}: *Perceived usefulness has no positive influence on behavioural intentions to adopt a hackathon*

H_{R6}: *Perceived usefulness has a positive influence on behavioural intentions to adopt a hackathon*

3.5.7 Perceived Ease of Use

This refers to the degree to which a person believes that using a particular system would be free of effort (Davis, 1989; Venkatesh and Bala, 2008; Venkatesh et al., 2003). It is one of the two constructs that uniquely identifies TAM which has been widely applied to a diverse set of technologies and users. In this research context, perceived ease of use refers to the degree to which a person believes that using a particular system would be free of effort in learning computer programming. To explain perceived ease of use toward hackathon adoption, the author proposed the following hypothesis:

Correlation Analysis:

H_{C0}: *Perceived ease of use has no relationship with behavioural intentions to adopt a hackathon*

H_{C7}: *Perceived ease of use has a positive relationship with behavioural intentions to adopt a hackathon*

Regression Analysis:

H_{R0}: *Perceived ease of use has no positive influence on behavioural intentions to adopt a hackathon*

H_{R7}: *Perceived ease of use has a positive influence on behavioural intentions to adopt a hackathon*

3.5.8 Relative Advantage

This is the degree to which using an innovation is perceived as being better than using its precursor (Moore and Benbasat, 1991). Grounded in sociology, IDT has been used to study a variety of innovations (Rogers, 1987; Rogers, 2002; Tornatzky et al., 1990). Within information systems, Moore and Benbasat (1991) adapted the characteristics of innovations presented in Rogers and refined a set of constructs that could be used to study individual technology acceptance. In this research context, relative advantage refers to the degree to which a person perceives hackathons to be better than other teaching methods that have been used to learn computer programming. To explain relative advantage towards hackathon adoption, the author proposed the following hypothesis:

Correlation Analysis:

H_{C0}: *Relative advantage has no relationship with behavioural intentions to adopt a hackathon*

H_{C8}: *Relative advantage has a positive relationship with behavioural intentions to adopt a hackathon*

Regression Analysis:

H_{R0}: *Relative advantage has no positive influence on behavioural intentions to adopt a hackathon*

H_{R8}: *Relative advantage has a positive influence on behavioural intentions to adopt a hackathon*

3.5.9 Self-efficacy

The judgment of one's ability to use a technology (e.g., computer) to accomplish a particular job or task (Compeau and Higgins, 1995; Venkatesh and Bala, 2008; Venkatesh et al., 2003). Compeau and Higgins (1995) model studied computer use but the nature of the model and the underlying theory allow it to be extended to acceptance and use of information technology in general. Within this study, self-efficacy was measured by the degree to which an individual

believes that he or she can perform a specific task/job using the hackathon to accomplish a programming task. Consequently, the following hypothesis was proposed.

Correlation Analysis:

H_{C0}: *Self-efficacy has no relationship with behavioural intentions to adopt a hackathon*

H_{C8}: *Self-efficacy has a positive relationship with behavioural intentions to adopt a hackathon*

Regression Analysis:

H_{R0}: *Self-efficacy has no positive influence on behavioural intentions to adopt a hackathon*

H_{R9}: *Self-efficacy has a positive influence on behavioural intentions to adopt a hackathon*

3.5.10 Behavioural Intention

Behavioural intention is defined as an individual's intention to adopt and make use of a certain tool in the future (Ajzen, 1991; Taylor and Todd, 1995; Venkatesh et al., 2003). Ajzen (1991) suggests that behavioural intention is counted to have a direct influence on adoption and is consistent with Venkatesh et al. (2003) findings that behavioural intention will have a significant positive influence on technology usage based on underlying theory for all the intention models reviewed in their study. According to Irani et al. (2009), the majority of technology adoption research has utilised behaviour intention to predict technology adoption. The study will therefore use behavioural intention to measure hackathon adoption.

The following Table 3.7 summarises the proposed research hypotheses that have been discussed in the above-mentioned sections about the main factors that influence hackathon adoption for teaching and learning of computer programming in HE institutions:

Table 3-7: Summary of correlation research hypotheses

H No	Proposed Correlation Hypothesis
H_{C0}	Performance expectancy has no relationship with behavioural intentions to adopt hackathon
H_{C1}	Performance expectancy has a positive relationship with behavioural intentions to adopt hackathon
H_{C0}	Effort expectancy has no relationship with behavioural intentions to adopt hackathon
H_{C2}	Effort expectancy has a positive relationship with behavioural intentions to adopt hackathon
H_{C0}	Facilitating conditions has no relationship with behavioural intentions to adopt hackathon
H_{C3}	Facilitating conditions has a positive relationship with behavioural intentions to adopt hackathon
H_{C0}	Attitude has no relationship with behavioural intentions to adopt hackathon
H_{C4}	Attitude has a positive relationship with behavioural intentions to adopt hackathon
H_{C0}	Subjective norm has no relationship with behavioural intentions to adopt hackathon
H_{C5}	Subjective norm has a positive relationship with behavioural intentions to adopt hackathon
H_{C0}	Perceived usefulness has no relationship with behavioural intentions to adopt hackathon
H_{C6}	Perceived usefulness has a positive relationship with behavioural intentions to adopt hackathon
H_{C0}	Perceived ease of use has no relationship with behavioural intentions to adopt hackathon
H_{C7}	Perceived ease of use has a positive relationship with behavioural intentions to adopt hackathon
H_{C0}	Relative advantage has no relationship with behavioural intentions to adopt hackathon
H_{C8}	Relative advantage has a positive relationship with behavioural intentions to adopt hackathon
H_{C0}	Self-efficacy has no relationship with behavioural intentions to adopt hackathon
H_{C9}	Self-efficacy has a positive relationship with behavioural intentions to adopt hackathon

Table 3-8: Summary of regression research hypothesis

H No	Proposed Regression Hypothesis
H_{R0}	Performance expectancy has no positive influence on behavioural intentions to adopt hackathon
H_{R1}	Performance expectancy has a positive influence on behavioural intentions to adopt hackathon
H_{R0}	Effort expectancy has no positive influence on behavioural intentions to adopt hackathon
H_{R2}	Effort expectancy has a positive influence on behavioural intentions to adopt hackathon
H_{R0}	Facilitating condition has no positive influence on behavioural intentions to adopt hackathon
H_{R3}	Facilitating condition has a positive influence on behavioural intentions to adopt hackathon
H_{R0}	Attitude has no positive influence on behavioural intentions to adopt hackathon
H_{R4}	Attitude has a positive influence on behavioural intentions to adopt hackathon
H_{R0}	Subjective norm has no positive influence on behavioural intentions to adopt hackathon
H_{R5}	Subjective norm has a positive influence on behavioural intentions to adopt hackathon
H_{R0}	Perceived usefulness has no positive influence on behavioural intentions to adopt hackathon
H_{R6}	Perceived usefulness has a positive influence on behavioural intentions to adopt hackathon
H_{R0}	Perceived ease of use has no positive influence on behavioural intentions to adopt hackathon
H_{R7}	Perceived ease of use has a positive influence on behavioural intentions to adopt hackathon
H_{R0}	Relative advantage has no positive influence on behavioural intentions to adopt hackathon
H_{R8}	Relative advantage has a positive influence on behavioural intentions to adopt hackathon
H_{R0}	Self-efficacy has no positive influence on behavioural intentions to adopt hackathon
H_{R9}	Self-efficacy has a positive influence on behavioural intentions to adopt hackathon

3.6 Conditions to Accept or Reject the Hypotheses

The hypotheses are going to be tested using $\alpha = 0.05$ as the critical point using 95% confidence interval.

3.7 Chapter Summary

This chapter identified several technology adoption theories and models that can influence hackathon adoption using literature, theoretical, and empirical contexts. Technology adoption refers to the choices an individual makes in adopting and accepting or otherwise rejecting new technologies. Technology adoption theories identified are TAM, DOI, TPB, TAM 2, TAM 3, TOE, Decomposed –TPB, UTAUT, among others. These theories were examined to investigate and determine the factors that will make up the conceptual hackathon adoption model for empirical testing to build the final hackathon adoption model for teaching and learning of CP in HEI.

Consequently, this chapter presented the research model based on literature and the output of a methodical review of empirical findings to understand the various factors influencing hackathon adoption. Hypotheses were generated from the hackathon conceptual model to explore the factors that affect the hackathon adoption and explained the importance of each construct. Nine constructs (perceived ease of use, perceived usefulness, performance expectancy, facilitating conditions, attitude towards use, relative advantage, self-efficacy, subjective norm, and effort expectancy) were found to influence behavioural intention to adopt hackathon. The hackathon conceptual model developed will form the basis of the empirical research conducted in chapters five and six which can then be used as a frame of reference by HEIs that seek to adopt hackathon. Furthermore, the model can serve as a decision-making tool to support educational institutions and other organisations in their efforts to implement and diffuse hackathons in the context of teaching and learning.

CHAPTER 4 RESEARCH METHODOLOGY

4.1 Introduction

This chapter presents in detail the study's research methodology. Research methodology refers to the principles, procedures, and practices that guide a researcher to choose one set of research methods over another for conducting his/her research (Marczyk et al., 2010; Saunders et al., 2016; Wahyuni, 2012). This study adopted the Honeycomb Research Methodology. This methodology displays connections between methods and its supporting rationale (Wilson, 2014). The model is presented in Figure 4.1 as a computational framework to guide the structure of the study.

Figure 4-1: The Honeycomb of research methodology (Wilson 2014)

4.2 Research Philosophy

Research philosophy embodies a researcher's perception of truth, reality, and development of knowledge in a particular field (Saunders et al., 2016). It defines a researcher's beliefs and values that guide the design, collection and analysis of data in a research study (Ryan, 2018). These

include assumptions about a researcher's epistemology (the nature of knowledge), ontology (the nature of reality), and axiology (the role a researcher's values) in the research process (Bunniss and Kelly, 2010; Ponterotto, 2005; Wilson, 2014). These assumptions inevitably shape how a researcher understands his/her research questions, the methods used and his/her interpretation of research findings (Saunders et al., 2016).

4.2.1 Epistemology

Epistemology concerns assumptions about knowledge, what constitutes acceptable, valid, and legitimate knowledge, and how we can communicate knowledge to others (Saunders et al., 2016). The epistemology guides a researcher's view of knowledge which could be the positivist, interpretivist, or the pragmatism paradigm. A positivist researcher sees knowledge as objective and generalisable where theory can be developed accurately to describe the world. In contrast, an interpretivist researcher sees knowledge as subjective, meaning that there are multiple, diverse interpretations of reality. There is no one ultimate or 'correct' way of knowing (Bunniss and Kelly, 2010). A pragmatist researcher uses all available approaches to understand the problem rather than focusing on methods. In pragmatism, truth is what works at the time and pragmatists believe in an external world independent of the mind as well as that lodged in the mind (Haddadi et al., 2017). Pragmatist researchers favour working with both quantitative and qualitative data because it enables them to better understand social reality (Wahyuni, 2012).

4.2.2 Ontology

Ontology refers to assumptions about the nature of reality. The ontology guides a researchers view of reality which is either objective (reality is static and fixed) or subjective (reality is subjective and changing) (Bunniss and Kelly, 2010). An objectivist researcher believes that there is only one true social reality experienced by all social actors which is made up of solid, granular and relatively unchanging 'things', including major social structures into which individuals are born (Saunders et al., 2016). In contrast, the subjectivist researcher is interested in different opinions and narratives that can help to account for different social realities of different social actors. Subjectivists believe that as they actively use these data, they cannot detach themselves from their own values. They therefore openly acknowledge and actively reflect on and question their own values and incorporate these within their research (Saunders et al., 2016).

4.2.3 Axiology

Axiology refers to the role of values and ethics within the research process. It incorporates questions about how we, as researchers, deal with both our own values and those of our research participants. The researcher's value can be value-free (researcher is detached and maintains an

objective stance), value-bound (researchers are subjective) and value-driven (researcher initiated and sustained by researcher's doubt and beliefs) (Saunders et al., 2016).

4.2.4 Conclusion

The research followed a positivist paradigm (epistemology) as the study's findings are generalisable which can be applied to various fields and the ontology believes in a fixed reality (objective). The questionnaire was sent to participants and the responses are strictly from the participants without the researchers influence which makes the responses value free (axiology).

4.3 Research Approach

To understand how theories and conclusions are found in the data, a researcher must understand the different philosophical approach, that is, the reasoning applied to data to obtain the results (Ryan, 2018). There are two contrasting approaches to the reasoning adopted – inductive and deductive. Inductive research starts by collecting data to explore a phenomenon (observation, experiment and measurement, and generalisation and finding patterns in data) and the researcher generates or builds theory (often in the form of a conceptual framework) to describe the situation. On the other hand, deductive research starts by allowing a researcher to find a theory, often developed from reading academic literature, make predictions based on the theory, and then use a research strategy (observation or experiment) to test the theory (Ryan, 2018; Saunders et al., 2016; Wilson, 2014).

4.3.1 Conclusion

This research adopted the deductive approach where the theoretical framework was used to derive the proposed hackathon conceptual model and the hypotheses were developed from the model.

4.4 Research Strategy

The way a researcher answers his/her research question is influenced by his/her research philosophy and research approach. Research strategies emphasise the principles, procedures, and practices that govern research and the process by which the research is conducted (Antwi and Hamza, 2015; Wedawatta et al., 2011). It translates a researcher's ontological and epistemological principles into guidelines that show how his/her research is to be conducted (Ryan, 2018). Methodological choices that a researcher selects for his/her research strategy are quantitative, qualitative, and multi-strategy research. Quantitative research examines numerical data where the researchers consider it to be of primary importance to state one's hypotheses and then test those hypotheses with empirical data to see if they are supported (Creswell, 2013;

Wilson, 2014). In contrast, qualitative inquiry examines data that are narrative and used when little is known about a topic or phenomenon and when one wants to discover or learn more about it (Creswell, 2013; Wilson, 2014). Qualitative research is commonly used to understand people's experiences and to express their perspectives (Antwi and Hamza, 2015). In mixed research, the researcher combines the use of quantitative and qualitative data collection techniques and analytical procedures and concepts in a single research study or in a set of related studies (Antwi and Hamza, 2015; Creswell, 2013; Saunders et al., 2016).

4.4.1 Conclusion

This research adopted the quantitative research strategy to measure students' perceptions of hackathon adoption due to the positivist philosophical paradigm which underpins quantitative methodology and is often associated with a deductive approach.

4.5 Research Design

Research design represents the researcher's framework for his/her data collection and data analysis (Saunders et al., 2016; Wilson, 2014). Marczyk et al. (2010) refer to the many ways in which research can be conducted to answer the question being asked or the plan used to examine the question of interest. Furthermore, Saunders et al. (2016) describes it as the methodological link between a researcher's philosophy and subsequent choice of methods to collect and analyse data. It comprises the following seven types: action research, case study design, experimental design, longitudinal design, cross-sectional design, archival analysis design, and comparative design (Wilson, 2014).

4.5.1 Action Research

This research type is an emergent and iterative process of inquiry that is designed to develop solutions to real organisational problems through a participative and collaborative approach, which uses different forms of knowledge, and which will have implications for participants and the organisation beyond the research project (Marczyk et al., 2010; Wilson, 2014).

4.5.2 Case Study

A case study is used to conduct an in-depth examination of a single person or a few people. It is a unique method of observing a phenomenon in its natural environment through data. Case studies of individual participants often include in-depth interviews with participants and collaterals (e.g., friends, family members, colleagues), review of medical records, observation, and excerpts from participants' personal writings and diaries. Case studies have a practical function in that they can be immediately applicable to the participant's diagnosis or treatment. It expands our

knowledge about the variations in human behaviour. The case study requires a considerable amount of information, and therefore conclusions are based on a much more detailed and comprehensive set of information than is typically collected by experimental and quasi-experimental studies (Marczyk et al., 2010).

4.5.3 Experimental

Experimental research adheres to a scientific research design that includes a hypothesis, a variable that can be manipulated by the researcher, and variables that can be measured, calculated, and compared. The data collected is analysed by the research and the result will either support or reject the hypothesis. The null hypothesis predicts a non-significant relationship or difference between the variables and the alternative hypothesis predicts a significant relationship or difference between the variables (Marczyk et al., 2010; Saunders et al., 2016).

4.5.4 Longitudinal

The main strength of longitudinal research is its capacity to study change and development. This type of study may also provide you with a measure of control over some of the variables being studied (Saunders et al., 2016).

4.5.5 Cross-sectional

It involves a study that analyses data from a particular phenomenon at a particular time or over a short period (Levin, 2006; Wang and Cheng, 2020). Cross-sectional studies aim to obtain reliable data that makes it possible to generate, robust conclusions, and create new hypotheses that can be investigated with new research (Zangirolami-Raimundo et al., 2018). It often employs the quantitative, qualitative, and multi-strategy research survey strategy and seeks to describe the incidence of a phenomenon (for example, the IT skills possessed by managers in one organisation at a given point in time).

4.5.6 Archival Analysis

Archival analysis is a method applied to the study of historical documents and textual materials about phenomena that have been digitised. This potentially provides a researcher with considerable scope to design a research project that capitalises on a wide range of available data sources. It provides a window into the distant past about organisations, individuals, or events. It has been expanded to include digital texts, audio, and visual representations such as letters, social media, diaries, calendars, agenda and minutes of meetings, contracts, memos, personnel records, plans, policy statements, press releases, reports and strategy documents, publications, reports and national statistics, advertising posters, artefacts, audio recordings, audio-visual

corporate communications, digital recordings, DVDs, films, photographs, products, promotional advertisements and recordings, television and radio programmes and web images, etc (Saunders et al., 2016).

4.5.7 Conclusion

This research adopted the experimental and cross-sectional research design. The experimental research was chosen because data in experimental research are easily quantified or measured and seeks to determine the relationship between two variables and the influence of the independent variable on the dependent variable. Hence, correlation and regression are used. On the other hand, the cross – sectional study was chosen because it is usually inexpensive and easy to conduct and is useful for establishing preliminary evidence in planning a future advanced study. It is associated with the quantitative research strategy adopted for this study.

4.6 Data Collection

Data collection is concerned with different methods of obtaining data by a researcher as well as obtaining responses to research questions (Saunders et al., 2016; Wilson, 2014). This includes primary and secondary sources of data. Primary data refers to the first-hand data gathered by the researcher himself. Collecting primary data includes observation, interviews (semi-structured, in-depth and group interviews) and questionnaires (self-completed and interviewer-completed questionnaires. On the other hand, secondary data is the data that has already been collected through primary sources and made readily available for researchers to use for their own research (Acharya et al., 2013; Ponto, 2015; Saunders et al., 2016; Wahyuni, 2012; Wilson, 2014).

4.6.1 Primary Data Sources

Observation is another versatile approach to data collection. This method is adopted by a researcher if his/her research question(s) and objectives are concerned with what people do (direct observation of the construct of interest). It involves the systematic viewing, recording, description, analysis, and interpretation of people's behaviour (Saunders et al., 2016). This approach is an efficient way to collect data when the researcher is interested in studying and quantifying some type of behaviour (Marczyk et al., 2010).

Interview: The research interview is a purposeful conversation between two or more people, requiring the interviewer to create relationship and ask clear and precise questions, to which the interviewee is willing to pay attention to and respond. The use of interviews can help a researcher to gather valid and reliable data that are relevant to his/her research question(s) and objectives. It is a relatively inexpensive and efficient way to collect a wide variety of data that does not require

formal testing. One of the most common uses of the interview is to collect life histories and biographical data about the research participants and can also be used to help you refine your ideas where you have not yet fully formulated a research question and objectives (Marczyk et al., 2010; Saunders et al., 2016).

Questionnaire: Questionnaires can be used to describe all methods of data collection in which each person is asked to respond to the same set of questions in a predetermined order (Krosnick, 2018; Stone, 1993). It includes both face-to-face and telephone questionnaires as well as those in which the questions are answered without an interviewer being present. Self-completed questionnaires are usually completed by the respondents and are often referred to as surveys. Such questionnaires can be distributed to respondents through the internet (internet questionnaire), respondents either accessing the questionnaire through their web browser using a hyperlink (Web questionnaire) or directly via a QR (quick response) code scanned into their mobile device (mobile questionnaire) (Saunders et al., 2016).

4.6.2 Secondary Data Sources

When a researcher is expected to consider undertaking further analyses of data that were collected initially for some other purpose to answer their research question(s) or meet their objectives, such data are known as secondary data and include both raw data and published summaries. Once obtained, these data can be further analysed to provide additional or different knowledge, interpretations, or conclusions. According to Saunders et al. (2016), secondary data includes documents (text and non-test), surveys (censuses, continuous and regular surveys, and ad hoc surveys) and multiple sources (snap-shot and longitudinal) data.

4.6.3 Conclusion

The study primarily uses an online questionnaire as the source of data collection from respondents. The national state of disaster due to the Covid-19 pandemic and resultant safety protocols warranted careful deliberation on using this method. Also, it was a fast and cheap way of obtaining data.

4.7 Data Analysis Techniques

Data analysis is the process of capturing and storing data in the form of a data set for analysis purpose (Greasley, 2007). Knowledge about data analysis can help a researcher interpret data for the purpose of providing meaningful insights about the problem being examined (Marczyk et al., 2010; Wahyuni, 2012). Data analysis techniques includes descriptive statistics, inferential

statistics, grounded theory, narrative analysis, discourse analysis, visual analysis, and content analysis.

4.7.1 Descriptive Statistics

Descriptive statistics provide summary information about data by allowing the researcher to describe the data and examine relationships between variables (Greasley, 2007; Marczyk et al., 2010). Descriptive statistics are statistics that describes variables (nominal, ordinal, interval, and ratio) as well as measures of frequency count, percent, frequency), central tendency (mean, median, and mode), dispersion/variation (range, variance, standard deviation), and position (Percentile Ranks, Quartile Ranks) (Kaur et al., 2018). They are used to summarise data in an organised manner by describing the relationship between variables in a sample or population.

4.7.2 Inferential Statistics

Inferential statistics allow the researcher to examine causal relationships or help us to draw conclusions beyond our immediate samples and data (Greasley, 2007; Marczyk et al., 2010). An inferential statistical test is one whereby inference is made about the population based upon analysis of a sample selected from that population. Common methodologies in inferential statistics are one sample test of difference/One sample hypothesis test, confidence intervals, T-test, analysis of variance (ANOVA), contingency tables, chi square statistic, Pearson correlation, and regression analysis.

4.7.3 Conclusion

The study used the descriptive and inferential statistics to analyse the responses using SPSS 27 software. Descriptive analysis used for the study were frequency, measures of central tendency, and dispersion while inferential statistics used for the study were one sample t-test, Pearson corelation and multiple regression.

4.8 Detailed Research Design

A detailed explanation of the data collection and data analysis phase in the research process is presented in Figure 4.2. It helps to identify the essential components of the research process and the way the data analysis was conducted as described in the next chapter.

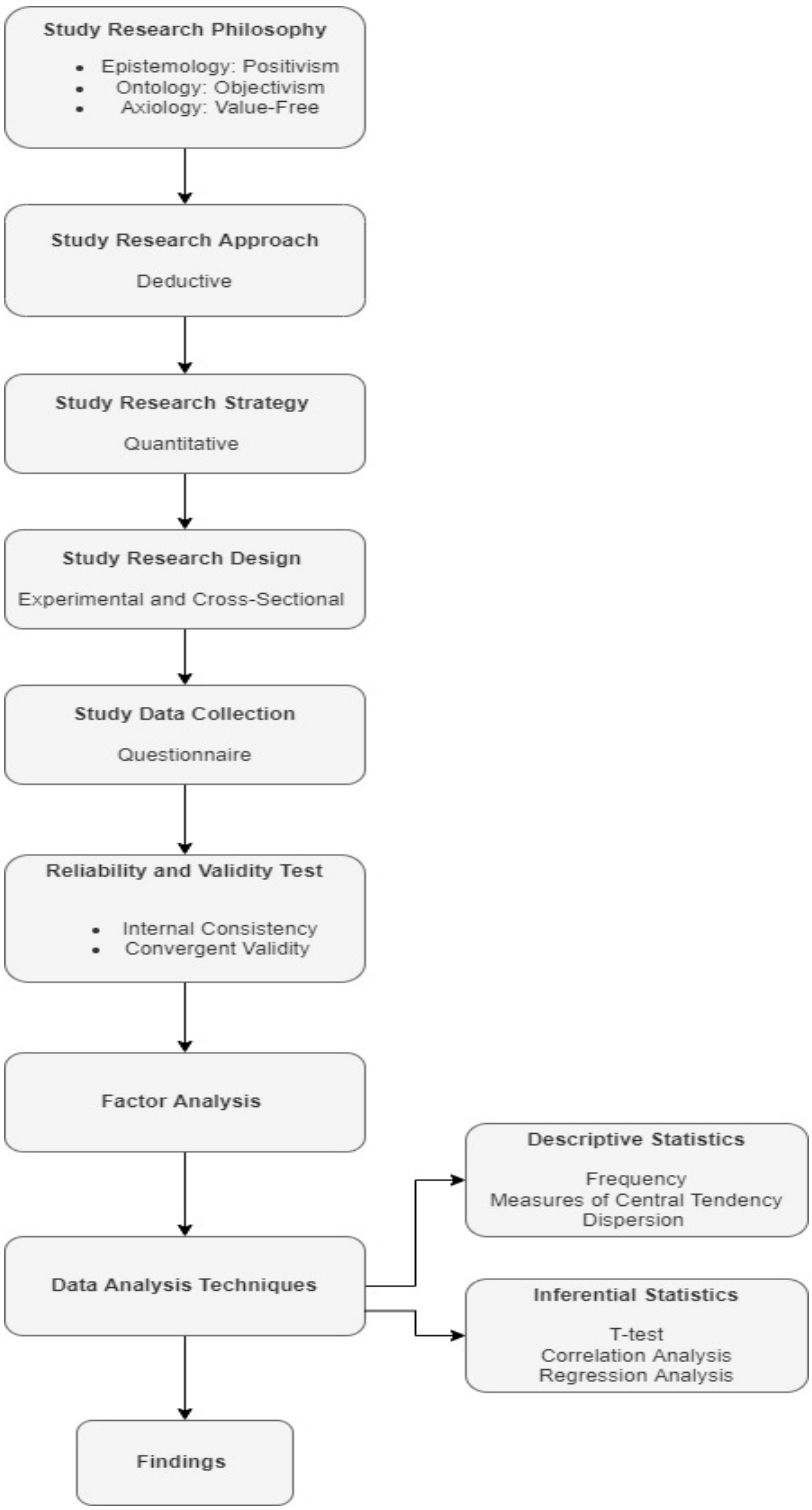

Figure 4-2: Detailed study research design

4.8.1 Population

Research population is the full set of cases from which a sample is drawn (Khalid et al., 2012). The study population for this study were students studying IT programming modules from universities of technologies in South Africa.

4.8.2 Sampling and Sample Size

The sampling in survey research is to obtain enough samples that are representative of the population of interest as it is often not practicable to collect data from an entire population of interest (Acharya et al., 2013; Khalid et al., 2012; Ponto, 2015). Sampling is thereby important because, in most cases, it is not realistic to study all the individual members of a population thereby saving time and optimising the use of resources in research endeavours (Acharya et al., 2013). Random sampling (probability) and non- random sampling (non-probability sampling) are types of sampling methods. Random sampling is one in which the researcher ensures that each participant of the sampling frame has an equal chance of selection as a study participant. On the contrary, in non-random sampling, each member of the population does not have an equal chance of selection as a participant in the study (Acharya et al., 2013; Khalid et al., 2012). Also, in simple random sampling procedure, the researcher must know every element in the population and for non-probability sampling, the researcher does not know the size or members of the population (Acharya et al., 2013).

Probability sampling is further classified into simple random sampling, stratified sampling, systematic random sampling, cluster sampling, multi-phase sampling and multi-stage sampling. On the other hand, non-probability methods used include convenience/purposive sampling, quota sampling, snowball sampling, etc. From the total population of IT programming students targeted for the study, the sample size was calculated using the formulae proposed by Cochran (1977) where the population size is unknown but the population proportion is known as shown below

$$n = \frac{p(1-p)z^2}{e^2}$$

$$n = \frac{0.1(1-0.1)(2.58)^2}{(0.05)^2} = 240$$

The following values as parameters from the above formulae: n = sample size, p = the population proportion (p=0.1), e = acceptable sampling error (e=0.05), z = z value at reliability level or significance level (Reliability level 95% or significance level 0.05; z = 1.96 and Reliability level 99% or significance level 0.01; z = 2.58). At the data collection stage, the study got a sample of 249 making the sample size ideal.

4.8.3 Questionnaire Design

Questionnaire design is important to ensure that the research questions are addressed, and accurate, and appropriate data for statistical analysis are collected (Buerhaus et al., 2012). An extensive study was conducted to obtain the most reliable and valid adoption questionnaires as

the instrument's measurement serves as a reliable source for the questionnaire design (Bryman, 2016). From the literature review, forty-four items presented in Table 4.1 were selected for the study which consisted of three items for the measurement of subjective norm and facilitating conditions (Taylor and Todd, 1995; Thompson et al., 1991; Venkatesh et al., 2003), four items for the measurement of effort expectancy, performance expectancy, attitude, and behavioural intentions (Davis, 1989; Taylor and Todd, 1995; Venkatesh et al., 2003), five items for the measurement of perceived ease of use, self-efficacy, and relative advantage (Moore and Benbasat, 1991; Ron et al., 2006; Venkatesh et al., 2003), and six items for the measurement of perceived usefulness (Davis, 1989; Venkatesh et al., 2003). A five-point Likert scale (1= Strongly Disagree, 2= Disagree, 3=Neutral, 4=Agree, 5= Strongly Agree) was used for each item.

Table 4-1: Questionnaire design

Constructs	**Conceptual Definition**	**Item code**	**Operational Constructs/Selected or modified items**	**Source adapted or modified from**
Effort Expectancy	The level of easiness related while using hackathon to learn Computer Programming.	EE1	Learning how to use hackathon will be easy for me.	(Venkatesh et al., 2013)
		EE2	My interaction with hackathon for Computer Programming task will be clear and understandable.	
		EE3	I will find hackathon easy to use.	
		EE4	It will be easy for me to become skilful at using hackathon to learn Computer Programming.	
Performance Expectancy	The degree to which the user expects that using the hackathon will help	PE1	I will find hackathon useful in learning Computer Programming.	(Venkatesh et al., 2013)

	him or her to attain gains computer programming.	PE2	Using hackathon will help/enable me to accomplish Computer Programming tasks more quickly.	
		PE3	Using hackathon will help/enable me to accomplish Computer Programming tasks more quickly.	
		PE4	Using hackathon will increase my chances of achieving Computer Programming tasks that are important to me.	
Attitude	An individual's positive or negative evaluation of the behaviour.	ATT1	Using the hackathon to learn CP is a good/bad idea.	(Taylor and Todd, 1995; Venkatesh et al., 2003)
		ATT2	Using the hackathon to learn CP hackathon is a wise/foolish idea.	
		ATT3	I like/dislike the idea of using the hackathon to learn CP.	
		ATT4	Using the hackathon to learn CP will be pleasant/unpleasant.	
Subjective Norm	An Individual's perception of social pressure to perform or not to perform the behaviour.	SN1	People who influence my behaviour think that I should use hackathon	(Taylor and Todd, 1995; Venkatesh et al., 2003)
		SN2	People who are important to me think that I should use hackathon	

		SN3	People whose opinions that I value prefer that I use hackathon	
Facilitating Conditions	The degree to which an individual believes that an organisational and technical infrastructure exists to support use of the system.	FC1	Guidance is available to me in using hackathon to learn CP.	(Thompson et al., 1991; Venkatesh et al., 2003)
		FC2	Specialised instruction concerning hackathon was available to me.	
		FC3	A specific person (or group) is available for assistance with difficulties in learning CP via hackathon.	
Perceived Usefulness	The degree to which an individual believes that an organisational and technical infrastructure exists to support use of the system.	PU1	Using hackathon to learn CP gives me greater control	(Davis, 1989; Venkatesh et al., 2003)
		PU2	Using hackathon to learn CP enables me to accomplish tasks more quickly	
		PU3	Using hackathon to learn CP supports critical aspects of learning.	
		PU4	Using hackathon to learn CP saves me time	
		PU5	Using hackathon to learn CP increases my productivity.	
		PU6	Overall, I find the hackathon useful in my studies.	

Perceived Ease of Use	Refers to a level of easiness that one feels when using a hackathon to learn CP.	PEOU1	Learning to operate the hackathon will be easy for me.	(Davis, 1989; Venkatesh et al., 2003)
		PEOU2	I will find it easy to get hackathon to do what I want it to do.	
		PEOU3	My interaction with hackathon will be clear and understandable.	
		PEOU4	I will find the hackathon to be flexible to interact with.	
		PEOU5	It will be easy for me to become skilful at using the hackathon to learn Computer Programming.	
Behavioural Intention	Refers to individual's intention to perform a behavior.	BI1	I plan to use hackathon for learning in the future.	(Taylor and Todd, 1995; Venkatesh et al., 2003)
		BI2	I intend to continue using hackathon for learning CP in the future.	
		BI3	I think hackathon should be implemented in learning CP.	
		BI4	I expect my use of hackathon to continue in the future.	
Self-Efficacy	The belief that one has the capability to perform a behaviour.	SE1	I could complete my learning activities using hackathon if there was no one around to tell me what to do	(Ron et al., 2006; Venkatesh et al., 2003)

		SE2	I could complete my learning activities using hackathon if I could call someone for help if I got stuck	
		SE3	I could complete my learning activities using hackathon if someone else had helped me get started	
		SE4	I could complete my learning activities using hackathon if I had a lot of time to complete the task for which Hackathon was provided	
		SE5	I could complete my learning activities using hackathon if I had instructions only instructions for reference	
Relative Advantage	Refers to the degree to which hackathon is more advantageous than other learning styles	RA1	Using the hackathon enables me to accomplish CP tasks more quickly.	(Moore and Benbasat, 1991; Venkatesh et al., 2003)
		RA2	Using the hackathon improves the quality of the CP work I do.	
		RA3	Using the hackathon makes it easier to learn.	
		RA4	Using the hackathon enhances my effectiveness in the class.	
		RA5	Using the hackathon increases my productivity.	

A pilot study was conducted to ascertain that the participants understood the questionnaire instrument as described in the next section.

4.8.4 Pilot Study

Pilot testing is an indispensable part of constructing a questionnaire because it provides constructive feedback on how straightforward the questionnaire is, and which concepts are ambiguous (Van Teijlingen and Hundley, 2001). Also, it was designed to test the applicability of the questionnaire items at the individual level to establish their reliability and construct validity aimed at determining construct validity and inter-item consistency reliability (In, 2017). For this study, the Cronbach's alpha method was implemented. In testing the preliminary survey questions, specific attention was paid to evaluate issues such as: the clarity of the questions, user-friendliness, the suitability of the questions for participants, respondents' interpretation of the items, and the estimated timeframe required for the questionnaire. These should be in line with the study aims.

The pilot study was comprised of 30 students studying IT programming courses from a university of technology. Data were collected via Blackboard as these students were the ones that responded to the questionnaire. Analysis of the pilot study data showed coefficient alpha values of PU = 0.862, PE = 0.909, RA = 0.882, SE = 0.874, PEOU = 0.756, BI = 0.838, FC = 0.810, SN = 0.888, ATT = 0.906, and EE = 0.805, thus confirming an acceptable internal consistency reliability and evidence of content and construct validity (Blunch, 2012). Exceeding a minimum α value of 0.70 for variables indicates that the variables are internally consistent and are good measures of the concept under study (Hair et al. 2006). In other words, a participant who answers a survey item positively is more likely to answer other items in the survey positively (Blunch, 2012). The pilot questionnaire provided useful feedback about clarifying some questions and the time estimation required to thoroughly answer all the questions

4.8.5 Data Collection

Of the IT programming students targeted as the population, a sample of 249 respondents participated in the survey. A limitation for engaging a larger sample emerged because of restricted movement due to the Covid-19 pandemic. The research used an online based learning management system called VUTELA was used to distribute the questionnaire. The online questionnaire was closed-ended which allowed the quantitative information received from them to be easily analysed. The questions within the questionnaire were designed to align with certain research objectives and used to gain a first insight into hackathon adoption for teaching and learning of CP in HE institutions.

To avoid errors during the data collection phase of this research, the following measures were implemented:

- The final questionnaire and instructions used in this survey were well-drafted to avoid respondent confusion.
- To address multiple submissions, the online based learning management system was setup to ensure that students could complete and submit the questionnaire only once, and thereafter the link was disabled. This allowed the researcher to avoid duplicate data in responses collected.

Only registered ICT students offering IT programming modules could access to the link to submit the questionnaire. This ensured the authenticity of the students who completed the questionnaire.

4.8.6 Reliability and Validity Test

Reliability and validity test were done to confirm if each item of the hackathon adoption instrument was reliable and valid. Reliability relates to the consistency of a measure while validity is about the accuracy of a measure (Heale and Twycross, 2015). Cronbach's alpha (α), the most common measure of scale reliability was used to measure the reliability of the scales for each of the constructs in the current study. Nonetheless, an acceptable alpha value above 0.7 is generally considered acceptable (Blunch, 2012). Internal consistency of each unidimensional latent constructs and its corresponding items was measured. Field (2009) supports dropping items that lead to substantial improvement in overall reliability. On the other hand, construct validity, a type of validity which measures the extent to which a research instrument (or tool) measures the intended construct was also used as a test of the validity of items in the research instruments. Since convergent and discriminant validities are the two fundamental aspects of construct validity (Heale and Twycross, 2015; Taherdoost, 2016), the convergent validity (measures of the same constructs) was the choice of the measure validity of items selected for the study.

4.8.7 Factor Analysis

Factor analysis allows for the reduction of many variables into a smaller number of factors. Factor analysis also known as exploratory factor analysis looks at the possibility of increasing the reliability of the scale by identifying inappropriate items that can then be removed. It identifies the attributes of constructs by examining relations between items and factors when the information of the attributes is limited (Netemeyer et al., 2003). Exploratory factor analysis (EFA) was conducted to determine the set of variables that are highly correlated to represent the dimensions within the data. For the study, EFA was performed in the early stages of developing a new or revised set of variables that identify dimensions that are latent (Costello and Osborne, 2005; Yong and Pearce, 2013).

Ten factors namely effort expectancy, performance expectancy, attitude, subjective norm, facilitating conditions, perceived usefulness, perceived ease of use, behavioural intentions, self-efficacy, and relative advantage were used to determine the structural pattern of the preliminary question set along with a scree plot and eigenvalue (Ledesma and Valero-Mora, 2007; Thompson, 2004). Scree tests, introduced by Cattell (1966), plot eigenvalues against the number of factors to best determine where a significant drop occurs within factor numbers (Netemeyer et al., 2003; Taherdoost et al., 2014). The factor solution was determined based on the numbers of eigenvalue that are greater than one (Kaiser, 1960; Taherdoost et al., 2014). Following Floyd and Widaman (1995) recommendations, 0.40 was used as a factor loading criterion in EFA.

The EFA process began with an initial analysis run to obtain eigenvalues for each factor in the data. This was followed by the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy test (to verify the sampling adequacy for the analysis) and Bartlett's Test of Sphericity (to determine if correlations between items were sufficiently large for EFA) to determine construct validity and confirm that the data collected for an EFA were appropriate. Bartlett's Test of Sphericity should reach a statistical significance of less than .05 to conduct an EFA. If the initial EFA results show items that are loading on the wrong factors or cross-loading on multiple factors, those items are deleted in order and the EFA re- performed until a simple solution is achieved.

Principal axis factoring (PAF) was used to extract the maximum variance in the indicators. For rotation, varimax rotation was used to explore the dataset. Initial data factorability was assessed using the Bartlett's test of Sphericity and the KMO measure of sampling to determine the underlying structure in the data. A KMO value of .60 and a significant ($\rho<.05$) Bartlett's Test of Sphericity are considered adequate for the main factor analysis to proceed (Yong and Pearce, 2013).

Based on Hair et al. (2010) recommendation, the study assessed the following loading against the following criteria:

- Factor loading between ±0.30 to ±0.40 was considered to meet the minimum level for interpretation structure.
- Loadings of ±0.40 or greater were considered practically significant.

In line with the criteria above, communalities of the items were examined, and any item with a communality value of below .03 was excluded because it was poorly accounted for by the factor solution (Hair et al., 2010). After conducting the second order factor analysis, an acceptable factor solution was obtained in which all variables had a significant loading on a factor for further analysis.

4.8.8 Detailed Data Analysis

The responses from the online questionnaire were analysed using the descriptive and inferential analysis techniques using SPSS 27 software.

4.8.8.1 Descriptive Statistics

Descriptive statistics are used to describe the data collected in research studies and to accurately characterise the variables under observation within a specific sample (Marczyk et al., 2010). The principal objective of descriptive statistics is to accurately describe distributions of certain variables within a specific data set (Marczyk et al., 2010; Saunders et al., 2016). It also summarises a study sample prior to analysing a study's primary hypotheses thereby providing information about the overall representativeness of the sample. According to Marczyk et al. (2010), various methods of examining distribution are frequency distribution, central tendency (mean, median, mode), and dispersion (variance). For this study, frequency, measures of central tendency, and dispersion were used.

4.8.8.2 Inferential Statistics

This is a technique that helps researchers conduct research with representative samples to draw inferences about the populations from which the samples were drawn because it would not be feasible to collect data from the entire population. The analyses used to examine these inferences are appropriately referred to as inferential statistics. Inferences begin with the formulation of specific hypotheses about what we expect to be true in the population. Selection of the numerous inferential statistics for researchers to choose from is largely determined by the nature of the research question being asked and the types of variables being analysed. Various inferential statistical procedures include the t-test, correlation analysis, chi-square, and regression. The inferential statistic used for the current study was the one sample t-test, factor analysis, correlation, and regression analysis.

4.8.8.2.1 One Sample T-test

This is a statistical hypothesis test used when a researcher wants to determine whether a known population mean is different from a specific value. This method provides reports for making inferences about a population mean based on a single sample (Marczyk et al., 2010). Table 4.2 summarises the research hypotheses that were tested to determine whether the participants had a defined opinion/perception other than neutral to ascertain whether they agreed or disagreed with the constructs that influence hackathon adoption for teaching and learning of CP in HEIs.

4.8.8.2.2 Correlation Analysis

A correlation coefficient provides a measure of the strength of the linear association between two variables giving an indication of the direction (either positive or negative) and strength of the relationship (Mukaka, 2012; Schober et al., 2018; Sedgwick, 2012). Correlation strength can be measured using Schober et al. (2018) guide, which states that from 0.00-.10 are considered "negligible", from 0.10-0.39 are considered "weak", from .40-.69 are considered "moderate", from .70-.89 are considered "strong" and from .90-1.0 are considered "very strong". Correlation tests can be performed using either the Spearman's rank correlation, the Karl Pearson's product-moment correlation, scatter diagrams or the coefficients of concurrent deviations (Saunders et al., 2016). The study used the Pearson's product-moment correlation for its correlation analysis.

Table 4-2: One sample t-test proposed hypothesis

Hypothesis	**Definition**
H_0: μ = 3	Participants do not have a defined opinion/perception for each proposed construct
H_1: μPerceived usefulness ≠ 3	Participants have a defined opinion/perception for perceived usefulness
H_1: μRelative Advantage ≠ 3	Participants have a defined opinion/perception for relative advantage
H_1: μPerformance Expectancy ≠ 3	Participants have a defined opinion/perception for performance expectancy
H_1: μSelf-Efficacy ≠ 3	Participants have a defined opinion/perception for self-efficacy
H_1: μBehavioural Intention ≠ 3	Participants have a defined opinion/perception for behavioural intention
H_1: μAttitude ≠ 3	Participants have a defined opinion/perception for attitude
H_1: μEffort Expectancy ≠ 3	Participants have a defined opinion/perception for effort expectancy
H_1: μFacilitating Condition ≠ 3	Participants have a defined opinion/perception for facilitating condition
H_1: μSubjective Norm ≠ 3	Participants have a defined opinion/perception for subjective norm
H_1: μPerceived Ease of Use≠ 3	Participants have a defined opinion/perception for perceived ease of use

4.8.8.2.3 Regression Analysis

Regression analysis is used as one of the inferential statistical techniques. Linear regression is a method of estimating or predicting a value on some dependent variable (DV) given the values of one or more independent variables (IV). Like correlations, statistical regression examines the association or relationship between variables or the method of identifying the variables that impact on a topic of interest (Marczyk et al., 2010). Regression analysis can be basically performed using

simple regression and a multiple regression method. In simple regression, we attempt to predict the dependent variable with a single independent variable. In contrast, multiple regression may use any number of independent variables to predict the dependent variable. The study performed simple regression allowing one to identify the important factors and their influence on the subject under study.

4.8.9 Ethical Considerations

Ethics are broad-based principles and rules of conduct that guide social scientists when doing their research (Connelly, 2014; Rogers, 1987). Various ethical issues such as the respondents' right to privacy, the use of deception, the respondents' right to be informed about the purpose of the research, the need for confidentiality, the need for honesty in collecting data, and the need for objectivity in reporting data apply to survey research (Ketefian, 2015; Rogers, 1987).

In dealing with ethical issues, Sekaran and Bougie (2016) suggested that researchers adhere to the following principles:

- The information given by respondents should be treated strictly confidential and guarding the respondent's privacy should be the researcher's primary responsibility.
- Personal, sensitive, and intrusive information should not be solicited from respondents. Suppose it is crucially necessary to do so, in that case, however, the researcher should display the highest degree of sensitivity to the respondent when seeking such information and should offer specific reasons for seeking it.
- Regardless of the data collection method to be pursued, the self-esteem and self- respect of the respondents should never be violated.
- No potential respondent should be forced to respond to a survey, and if a potential respondent does not want to participate in the study, his/her wish should be respected.
- There should be absolutely no misrepresentation or distortion in reporting data collected during the study.

Consistent with the preceding principles on research ethics, addressing ethical concerns was central to the planning and implementation of the research. The researcher addressed these concerns by taking the following steps, among others:

- Each questionnaire had a covering letter explaining the study's purpose; this letter also indicated that their responses would be treated with utmost confidentiality.
- Participants were recruited of their own free will and were allowed to withdraw at any time during the data collection process.

- The supervisor and researcher's contact details were given in the covering letter in case the respondents had any questions about the study or ethical concerns.

An ethics clearance application, which had the study questionnaire attached, was submitted to the university's Research Ethics Committee. The committee approved the research project, and an ethics clearance was issued.

4.9 Chapter Summary

This chapter discussed the chosen research methodology, the Honeycomb method as a foundation for the research methods used for the study to obtain the required data for empirical analysis. The Honeycomb method guides the collection and analysis of data that will be undertaken in the next chapter.

Consequently, based on the aim of the study to identify the factors that influence the adoption of hackathon for teaching and learning of CP, the research followed a positivist paradigm (epistemology) with an objective reality (ontology) and considered the responses value free (axiology) from the respondent. The research adopted the deductive approach where the theoretical framework was used to derive the proposed hackathon conceptual model and the hypotheses were developed from the model using a quantitative research strategy due to the positivist philosophical paradigm and its association with a deductive approach. In addition, the experimental and correlation research design was chosen because the experimental design seeks to determine a relationship between two variables while the cross-sectional study was chosen because it is cheap and easy to conduct. Furthermore, the questionnaire was selected as the source of data collection from respondents while the descriptive and inferential statistics were selected to analyse the responses. The next chapter presents the results of the analysis.

CHAPTER 5 RESEARCH RESULTS

5.1 Introduction

This chapter analyses and discusses the result of the survey which investigate the factors of hackathon adoption for teaching and learning of CP. The data were analysed using descriptive and inferential statistics: descriptive statistics including frequency tables, central tendency, and dispersion to observe the demographics and the mean of the respondents; inferential statistics in the form of a t-test to test the mean difference between groups; an EFA of the measurement items and their corresponding constructs to discover the factor structure of the constructs; Pearson correlation analysis to test the strength of linear relationships between the hackathon adoption variables; and the multiple regression analysis to predict the factors that determine hackathon adoption from our set of independent variables. The tests were performed using SPSS 27 software.

5.2 Reliability and Validity of Measurement Items

Reliability refers to consistency. Although for a questionnaire to be valid it must be reliable, this is not sufficient on its own. Reliability is therefore concerned with the robustness of your questionnaire and whether it will produce consistent findings at different times and under different conditions (Saunders et al., 2016). Approaches to assessing reliability to compare the data collected with other data from various sources to confirm its authenticity and dependability includes test re-test, internal consistency, and alternative form (Saunders et al., 2016). This study conducted the internal consistency. Internal consistency was tested first using Cronbach's alpha followed by exploratory factor analysis to verify the factors underlying the variables.

5.2.1 Internal Consistency

A reliability test was done to confirm if each factor of the hackathon adoption instrument is reliable and valid. Cronbach's alpha (α), the most common measure of scale reliability, was used to assess the reliability of the scales for each of the constructs in this research. Nonetheless, there seems to be some disagreement regarding the acceptable value as Blunch (2012) generally considered acceptable an alpha above 0.7.

Internal consistency for our scales and its corresponding items is shown in Table 5.1 thus showing sound measurement reliability for the given factors and a recommended threshold for the internal consistency of measurement items between 0.7 and 0.9 for all factors. This implies the set of items used to measure the various unidimensional latent constructs have attained internal consistency, though, Field (2009) supports dropping items that lead to substantial improvement

in overall reliability. However, as seen in Table 5.1, dropping two items (PEOU3, and SE1) will considerably increase its overall reliability. Furthermore, the corrected item-total correlations of the same items were considerably lower than their counterparts. Thus, proper consideration was given to these items when moving into the exploratory factor analysis.

Table 5-1: Reliability assessment of items

Cronbach's Alpha Values	Items	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Effort Expectancy Cronbach's Alpha: **0,859**	EE1	0,675	0,834
	EE2	0,791	0,783
	EE3	0,660	0,838
	EE4	0,695	0,825
Performance Expectancy Cronbach's Alpha: **0,925**	PE1	0,787	0,915
	PE2	0,842	0,897
	PE3	0,852	0,894
	PE4	0,823	0,904
Attitude Cronbach's Alpha: **0,838**	ATT1	0,635	0,810
	ATT2	0,665	0,797
	ATT3	0,702	0,781
	ATT4	0,682	0,791
Social Norm Cronbach's Alpha: **0,832**	SN1	0,607	0,852
	SN2	0,738	0,725
	SN3	0,738	0,720
Facilitating Condition Cronbach's Alpha: **0,835**	FC1	0,675	0,790
	FC2	0,750	0,715
	FC3	0,663	0,802
Perceived Usefulness Cronbach's Alpha: **0,909**	PU1	0,766	0,891
	PU2	0,786	0,888
	PU3	0,793	0,888
	PU4	0,726	0,896
	PU5	0,719	0,897
	PU6	0,710	0,899
Perceived Ease of Use Cronbach's Alpha: **0,748**	PEOU1	0,563	0,700
	PEOU2	0,485	0,714
	PEOU3	0,278	**0,766***
	PEOU4	0,523	0,705
	PEOU5	0,638	0,671
	PEOU6	0,568	0,692
Behavioural Intention Cronbach's Alpha: **0,916**	BI1	0,792	0,897
	BI2	0,808	0,892
	BI3	0,852	0,877
	BI4	0,782	0,901
Self-Efficacy Cronbach's Alpha: **0,968**	SE1	0,560	**0,874***
	SE2	0,764	0,821
	SE3	0,687	0,841
	SE4	0,762	0,822
	SE5	0,694	0,839
	RA2	0,777	0,916

Relative Advantage Cronbach's Alpha: **0,926**	RA3	0,823	0,907
	RA4	0,821	0,907
	RA5	0,787	0,914

*Improved Cronbach's Alpha if item deleted.

5.2.2 Convergent Validity

A validity test was done to confirm the degree to which hackathon adoption instrument is accurately measured in the current study. Convergent validity, an aspects of construct validity which refers to how closely the new scale is related to other variables and other measures of the same construct was chosen. Table 5.2 to 5.5 presents and further discuss the analysis of the convergent validity method used.

For the convergent validity of scale for items EE, PE, and ATT in Table 5.2, all scales show a convergent validity because the correlation of all the items is within the range of 0.3 and 0.7 which indicates that the scales have good statistically significant validity.

Table 5-2: Convergent validity of scale for items EE, PE, and ATT

	EE1	EE2	EE3	EE4	PE1	PE2	PE3	PE4	ATT1	ATT2	ATT3	ATT4
EE1	1	.701**	.497**	.550**	.469**	.424**	.410**	.402**	.219**	.140*	.294**	.215**
EE2	.701**	1	.631**	.650**	.498**	.421**	.423**	.427**	.270**	.193**	.274**	.283**
EE3	.497**	.631**	1	.597**	.394**	.324**	.320**	.313**	.214**	.175**	.235**	.337**
EE4	.550**	.650**	.597**	1	.671**	.633**	.594**	.582**	.332**	.319**	.347**	.352**
PE1	.469**	.498**	.394**	.671**	1	.774**	.715**	.694**	.380**	.346**	.411**	.392**
PE2	.424**	.421**	.324**	.633**	.774**	1	.783**	.744**	.410**	.412**	.380**	.388**
PE3	.410**	.423**	.320**	.594**	.715**	.783**	1	.823**	.419**	.444**	.408**	.400**
PE4	.402**	.427**	.313**	.582**	.694**	.744**	.823**	1	.433**	.442**	.411**	.388**
ATT1	.219**	.270**	.214**	.332**	.380**	.410**	.419**	.433**	1	.519**	.585**	.515**
ATT2	.140*	.193**	.175**	.319**	.346**	.412**	.444**	.442**	.519**	1	.569**	.599**
ATT3	.294**	.274**	.235**	.347**	.411**	.380**	.408**	.411**	.585**	.569**	1	.603**
ATT4	.215**	.283**	.337**	.352**	.392**	.388**	.400**	.388**	.515**	.599**	.603**	1

For the convergent validity of scale for items SN, FC, and PU in Table 5.3, all scales show a convergent validity because the correlation of all the items is within the range of .3 and .7 which indicates that the scales have good statistically significant validity.

Table 5-3: Convergent validity of scale for items SN, FC, and PU

	SN1	SN2	SN3	FC1	FC2	FC3	PU1	PU2	PU3	PU4	PU5	PU6

SN1	1	.564**	.569**	.357**	.274**	.254**	.374**	.226**	.285**	.352**	.406**	.382**
SN2	.564**	1	.744**	.314**	.272**	.316**	.358**	.286**	.279**	.365**	.297**	.366**
SN3	.569**	.744**	1	.340**	.268**	.255**	.390**	.363**	.330**	.435**	.329**	.408**
FC1	.357**	.314**	.340**	1	.669**	.556**	.503**	.481**	.400**	.458**	.405**	.482**
FC2	.274**	.272**	.268**	.669**	1	.654**	.412**	.329**	.246**	.349**	.278**	.332**
FC3	.254**	.316**	.255**	.556**	.654**	1	.395**	.332**	.287**	.344**	.225**	.377**
PU1	.374**	.358**	.390**	.503**	.412**	.395**	1	.707**	.652**	.632**	.576**	.636**
PU2	.226**	.286**	.363**	.481**	.329**	.332**	.707**	1	.721**	.639**	.624**	.586**
PU3	.285**	.279**	.330**	.400**	.246**	.287**	.652**	.721**	1	.638**	.672**	.617**
PU4	.352**	.365**	.435**	.458**	.349**	.344**	.632**	.639**	.638**	1	.582**	.568**
PU5	.406**	.297**	.329**	.405**	.278**	.225**	.576**	.624**	.672**	.582**	1	.590**
PU6	.382**	.366**	.408**	.482**	.332**	.377**	.636**	.586**	.617**	.568**	.590**	1

For the convergent validity of scale for items PEOU and BI in Table 5.4, all scales of BI show a convergent validity because the correlation of all the items is within the range of 0.3 and 0.7 which indicates that the scales have good statistically significant validity. All scales of PEOU show little to no convergent validity although some correlation of all the items falls between the range of 0.3 while other items are within the range of 0.3 and 0.7. As seen in Table 5.6, item PEOU3 has a lower correlation than its counterpart item which affected the validity of the scales for that construct. Thus, proper consideration was given to these items when moving into the exploratory factor analysis.

Table 5-4: Convergent validity of scale for items PEOU and BI

	PEOU1	PEOU2	PEOU3	PEOU4	PEOU5	PEOU6	BI1	BI2	BI3	BI4
PEOU1	1	.390**	.187**	.380**	.501**	.425**	.340**	.338**	.366**	.425**
PEOU2	.390**	1	.173**	.378**	.378**	.314**	.263**	.277**	.255**	.281**
PEOU3	.187**	.173**	1	.242**	.235**	.165**	0,062	.123*	.126*	.249**
PEOU4	.380**	.378**	.242**	1	.429**	.411**	.300**	.303**	.271**	.304**
PEOU5	.501**	.378**	.235**	.429**	1	.575**	.349**	.336**	.378**	.371**
PEOU6	.425**	.314**	.165**	.411**	.575**	1	.495**	.439**	.464**	.422**
BI1	.340**	.263**	0,062	.300**	.349**	.495**	1	.699**	.774**	.693**
BI2	.338**	.277**	.123*	.303**	.336**	.439**	.699**	1	.781**	.718**
BI3	.366**	.255**	.126*	.271**	.378**	.464**	.774**	.781**	1	.733**
BI4	.425**	.281**	.249**	.304**	.371**	.422**	.693**	.718**	.733**	1

For the convergent validity of scale for items SE and RA in Table 5.5, all scales show a convergent validity because the correlation of all the items is within the range of 0.3 and 0.7 which indicates that the scales have good statistically significant validity.

Table 5-5: Convergent validity of scale for items SE and RA

	SE1	SE2	SE3	SE4	SE5	RA1	RA2	RA3	RA4	RA5
SE1	1	.543**	.382**	.493**	.487**	.481**	.468**	.472**	.469**	.436**
SE2	.543**	1	.673**	.666**	.591**	.526**	.537**	.532**	.588**	.474**
SE3	.382**	.673**	1	.661**	.557**	.441**	.474**	.466**	.523**	.481**
SE4	.493**	.666**	.661**	1	.651**	.498**	.438**	.536**	.483**	.481**
SE5	.487**	.591**	.557**	.651**	1	.614**	.550**	.533**	.470**	.445**
RA1	.481**	.526**	.441**	.498**	.614**	1	.773**	.748**	.729**	.686**
RA2	.468**	.537**	.474**	.438**	.550**	.773**	1	.674**	.681**	.647**
RA3	.472**	.532**	.466**	.536**	.533**	.748**	.674**	1	.754**	.737**
RA4	.469**	.588**	.523**	.483**	.470**	.729**	.681**	.754**	1	.743**
RA5	.436**	.474**	.481**	.481**	.445**	.686**	.647**	.737**	.743**	1

5.3 Factor Analysis

Factor analysis represents a diverse statistical method that operates on the idea that measurable and observable variables can be reduced to fewer latent variables called factors (Yong and Pearce, 2013). Forty-four items were included in the factor analysis because they were thought to relate to the constructs it intends to measure. The perceived constructs (effort expectancy, performance expectancy, attitude, subjective norm, perceived usefulness, facilitating conditions, perceived ease of use, behavioural intentions, self-efficacy, and relative advantage) were obtained from the related literature on technology adoption. They were used to determine the pattern of the structure in the 44 item measurement of the hackathon adoption instrument along with a scree plot and eigenvalue (Thompson, 2004).

5.3.1 Assumptions

While strict rules for sample size for EFA have waned, different ideas and suggestions from literature have emerged (Costello and Osborne, 2005; Tabachnick et al., 2007). A universal rule of thumb is to have five to ten participants per variable up to a total of 300, beyond which test parameters tend to stabilise regardless of participant to variable ratio (Tabachnick et al., 2007; Yong and Pearce, 2013). Hair et al. (2010) recommend a minimum sample size of 100 and above to achieve reliable results in factor analysis. The research has a sample size of 249 and a participant to variable ratio of 6:1, which according to extant literature, is satisfactory. Following Floyd and Widaman (1995) recommendations, 0.40 was used as a factor loading criterion in EFA.

5.3.2 Factorability

Factor analysis began by computing the KMO and Bartlett's Test of Sphericity to examine whether the underlying structure of the data is fit for factor analysis, and also to examine the existence of

relationships between items and factors when the information of the dimensionality is limited (Netemeyer et al., 2003). Table 5.6 shows an Initial KMO value of 0.933 was attained which is more than the 0.6 thresholds. Moreover, Bartlett's test of sphericity produced a significant ρ-value (< .000) which indicates that the factor model was appropriate and the correlations between items were sufficiently large to conduct an EFA.

Table 5-6: Initial KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,933
Bartlett's Test of Sphericity	Approx. Chi-Square	7821,188
	df	946
	Sig.	0,000

5.3.3 Factor Retention

Factor retention is an important question to ask when carrying out a factor analysis to know how many factors to retain or keep for further analysis. Since there is no precise basis for determining the number of factors to retain, the literature suggests relying on several criteria when deciding on the appropriate number of factors (Hair et al., 2010; Tabachnick et al., 2007). Kaiser's criterion by Kaiser is one of the known simplest criteria for factor retention by suggesting retention of all factors with eigenvalues greater than 1, while ignoring those with smaller eigenvalues (Costello and Osborne, 2005; Hair et al., 2010; Netemeyer et al., 2003). This criterion suggest that eigenvalues characterize the amount of variation explained by its associated factor and that eigenvalues greater than 1 represent a considerable amount of variation (Field, 2009; Netemeyer et al., 2003). From the result of Table 5.7, eleven factors have variance with eigenvalues greater than 1.

Scree test is another known criterion proposed to determine the number of factors to retain. Cattell (1966) proposed plotting a graph of each eigenvalue against its associated factor in identifying the total number of factors to be extracted. The graph proposed by Cattell has a distinct shape and there is initially a steep downward curve that gradually becomes horizontal. Cattell (1966) argues that the point at which this curve first begins to straighten out indicates the cut-off point for selecting factors. For the study, SPSS software provided a scree plot for choosing the appropriate number of factors to retain. The resulting screen plot in Figure 5.1 suggests about nine meaningful factors – and hence nine factors were retained. The number of factors to be retained was chosen based on the scree plot which showed a smooth decrease in eigenvalues after the ninth factor.

Table 5-7: Initial total variance explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	17,083	38,825	38,825	16,743	38,051	38,051
2	2,751	6,251	45,076	2,408	5,473	43,525
3	2,158	4,904	49,980	1,784	4,054	47,578
4	1,941	4,411	54,391	1,541	3,503	51,082
5	1,861	4,230	58,621	1,488	3,382	54,464
6	1,674	3,805	62,426	1,318	2,996	57,460
7	1,419	3,225	65,651	1,108	2,519	59,979
8	1,081	2,458	68,109	0,710	1,613	61,592
9	1,021	2,321	70,430	0,681	1,547	63,140
10	0,901	2,048	72,479			
11	0,782	1,778	74,257			
…	…	…	…			
44	0,104	0,237	100,000			

Extraction Method: Principal Axis Factoring.

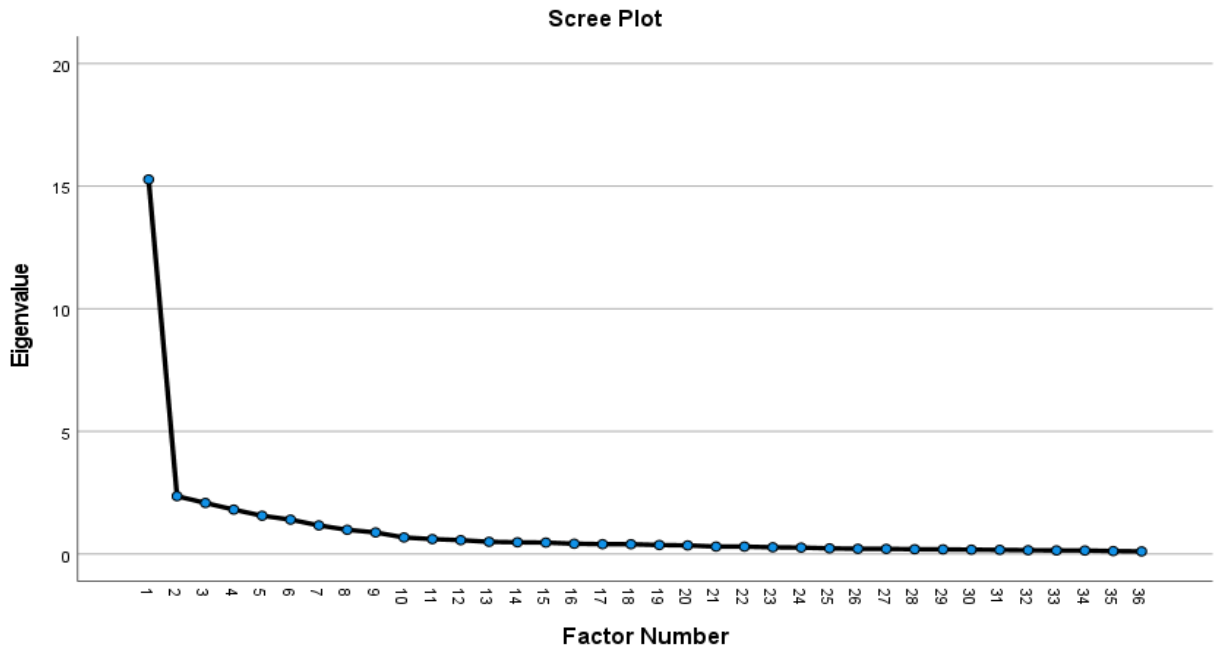

Figure 5-1: Scree plot

5.3.4 Extraction Method

Numerous extraction methods exist which include alpha factoring, unweighted least squares, image factoring, and generalised least squares (Tabachnick et al., 2007; Taherdoost et al., 2014; Thompson, 2004). Certain literature suggests using principal component analysis (PCA), principal axis factoring (PAF), and maximum likelihood (ML) regarding factor extraction methods in EFA (Baglin, 2014; Costello and Osborne, 2005; De Winter and Dodou, 2012). PAF and ML remain the most popular in literature and tend to give the best results based on the nature of the underlying distribution of the data (Baglin, 2014; De Winter and Dodou, 2012). For this reason, PAF was chosen as the recommended extraction method for this research.

5.3.5 Rotation Method

The result of a factor analysis is not easily understood without a rotation, thus, researchers must decide upon a factor rotation to improve the explanation and the value of the factor solution (Field, 2009; Tabachnick et al., 2007). The decision is between orthogonal rotation which produces uncorrelated factors and oblique rotation which allows factors to correlate (Baglin, 2014). Due to its (mathematical) simplicity and the ease of interpreting the factors, scholars have historically favoured orthogonal rotation, whereas modern research seem to favour oblique rotation (Costello and Osborne, 2005). Hence, the orthogonal rotation is unlikely to be considered ‘best practice’. However, as the oblique rotation gave unintelligible and erratic results when employed on the data in the study, an orthogonal rotation (direct oblimin) was chosen.

5.3.6 Final EFA Result

The steps by which problematic items were removed from further analysis and a simple factor structure was achieved in a final EFA are presented, including a discussion of the identification and removal of problematic measurement items through re-analysing the EFA. Lastly, the final EFA is presented with a simple factor structure.

5.3.6.1 Conducting the EFA

The choice of using an EFA was because the researchers had no a priori expectations regarding the number and nature of underlying factors. PAF was selected for factor extraction initially on all 44 items with orthogonal (direct oblimin) used for factor rotation. The direct oblimin rotation was employed to evaluate factor loadings that correlate the factors and the variables. The number of factors was fixed for further analysis given the a priori criterion of nine factors as shown in Table 5.8 which also shows the cumulative variance while the initial communalities and factor loadings (rotated factor matrix) are presented in Table 5.9 and Table 5.11.

Table 5-8: Final solution - Total variance explained

Total Variance Explained									
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	15,275	42,431	42,431	14,975	41,598	41,598	3,771	10,475	10,475
2	2,361	6,558	48,988	2,077	5,770	47,367	3,145	8,737	19,212
3	2,084	5,789	54,778	1,746	4,850	52,217	3,039	8,440	27,652
4	1,813	5,035	59,813	1,474	4,096	56,313	2,837	7,880	35,532
5	1,562	4,338	64,151	1,257	3,491	59,804	2,766	7,684	43,217
6	1,404	3,900	68,050	1,114	3,093	62,897	2,645	7,348	50,565
7	1,168	3,244	71,294	0,899	2,498	65,395	2,206	6,129	56,694
8	0,989	2,747	74,041	0,681	1,891	67,287	2,206	6,127	62,821
9	0,881	2,446	76,487	0,568	1,579	68,865	2,176	6,045	68,865
10	0,676	1,879	78,366						
11	…	…	…						
36	0,107	0,299	100,000						
Extraction Method: Principal Axis Factoring.									

Table 5-9: Initial rotated factor matrix and communalities

	Factor								
	1	2	3	4	5	6	7	8	9
PU2	0,742								
PU3	0,738								
PU1	0,604								
PU5	0,598								
PU4	0,597								
PU6	0,565								
PEOU5									
PE3		0,745							
PE4		0,740							
PE2		0,716							
PE1		0,635							
RA1			0,687						
RA3			0,648						
RA5			0,637						
RA4			0,599						
RA2			0,597						
SE4				0,722					
SE3				0,663					
SE2				0,660					
SE5				0,549					
BI3					0,733				

BI2					0,702				
BI1					0,649				
BI4					0,609				
EE2						0,789			
EE3						0,670			
EE1						0,657			
EE4		0,423				0,616			
ATT3							0,716		
ATT4							0,707		
ATT2							0,666		
ATT1							0,602		
FC2								0,827	
FC3								0,664	
FC1								0,629	
SN3									0,814
SN2									0,780
SN1									0,547
Extraction Method: Principal Axis Factoring. Rotation Method: Varimax with Kaiser Normalization.									
a. Rotation converged in 8 iterations.									

To reach a simple factor structure, several iterations of the EFA were conducted to identify problematic measurement items by evaluating each item's communality, factor loading, and cross-loadings. Based on a literature review to identify best practices in EFA, a set of criteria was established to remove poor items as presented in Table 5.10.

Table 5-10: Criteria for removal of factors

Pre-established criteria for item deletion	**Threshold**	**References**
Communalities	< 0,5	(Field, 2009; Hair et al., 2010; Taherdoost et al., 2014)
Factor Loadings	< 0,4	(Field, 2009; Hair et al., 2010; Tabachnick et al., 2007; Taherdoost et al., 2014)
Cross Loadings	> 0,4 or a difference of less than 0,2 from the items highest factor loading	(Costello and Osborne, 2005; Tabachnick et al., 2007)

The re-analysing of the EFA was done by removing items that failed to satisfy the criteria in Table 5.10. Of the forty-four measurement items in the initial EFA, eight were dropped over successive

iterations. The communalities of the items were examined which ranged from 0.5 to 0.8. All items used to measure the constructs are indicated in Table 5.11. Six items were dropped due to low communalities (< 0.5), two items were dropped due low factor loadings (< 0.4), and one item was dropped due to cross-loadings on two factors. In total, all items associated with perceived ease of use (PEOU1-PEOU6) were dropped, while one item was dropped from self-efficacy (SE1), and effort expectancy (EE4). The final model was re-analysed by deriving a new factor solution without the dropped items.

Table 5-11: Initial communalities

	Initial	Extraction
EE1	0,609	0,594
EE2	0,703	0,730
EE3	0,574	0,557
EE4	0,692	0,695
PE1	0,760	0,727
PE2	0,775	0,749
PE3	0,779	0,810
PE4	0,786	0,755
ATT1	0,597	0,599
ATT2	0,555	0,556
ATT3	0,629	0,583
ATT4	0,641	0,644
SN1	0,561	0,513
SN2	0,672	0,746
SN3	0,682	0,777
FC1	0,659	0,639
FC2	0,648	0,763
FC3	0,591	0,550
PU1	0,694	0,642
PU2	0,712	0,706
PU3	0,708	0,759
PU4	0,662	0,617
PU5	0,655	0,582
PU6	0,703	0,624
PEOU1	0,467	**0,483***
PEOU2	0,340	**0,319***
PEOU3	0,354	**0,263***
PEOU4	0,409	**0,385***
PEOU5	0,566	0,560
PEOU6	0,521	**0,495***
BI1	0,718	0,713
BI2	0,743	0,735
BI3	0,799	0,842
BI4	0,748	0,707
SE1	0,512	**0,432***

SE2	0,671	0,651
SE3	0,680	0,557
SE4	0,702	0,687
SE5	0,658	0,575
RA1	0,774	0,736
RA2	0,745	0,719
RA3	0,752	0,686
RA4	0,777	0,688
RA5	0,739	0,630
Extraction Method: Principal Axis Factoring.		

5.3.6.2 Final Factor Structure

The final factor structure was rerun with the remaining 36 items, with KMO of 0.931 and a significant Bartlett's test of sphericity ($p < 0.01$), indicating sufficient sampling adequacy and correlation between items (Table 5.12). The final analysis produced a simple factor structure (Table 5.13) in which each item loaded highly onto one and only one factor, while satisfying the item criteria in Table 5.10.

Table 5-12: Final Solution - KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,931
Bartlett's Test of Sphericity	Approx. Chi-Square	6825,596
	df	630
	Sig.	0,000

After examining the content of the items loading above 0.4 on each factor, the items that loaded highly on the same factors suggested that factor 1 was labelled perceived usefulness (PU). This included items such as 'Using the hackathon would enable me to accomplish learning CP more quickly' and 'I would find the hackathon useful in my learning CP'. The remaining Eight factors were labelled factor 2 relative advantage (RA), factor 3 performance expectancy (PE), factor 4 self-efficacy (SE), factor 5 behavioural intention, factor 6 attitude (ATT), factor 7 effort expectancy (EE), factor 8 facilitating conditions (FC), and factor 9 social norms (SN). Regarding the factor retention criteria, the factor solution can be supported by Kaiser's (1960) criterion (keep factors with eigenvalues > 1) and the variance criterion (Table 5.10), and Cattell (1966) scree test (Figure 5.1). The final EFA produced a simple structure of nine factors explaining 68.87% of the cumulative variance. These final factor structures were used to carry out the correlation and regression analysis in the next section.

Table 5-13: Final factor structure and communalities

	Factor									
	1	2	3	4	5	6	7	8	9	Communalities
PU3	0,747									0,755
PU2	0,735									0,734
PU1	0,609									0,661
PU4	0,597									0,617
PU5	0,592									0,599
PU6	0,548									0,608
RA1		0,687								0,788
RA3		0,661								0,759
RA5		0,648								0,686
RA4		0,611								0,727
RA2		0,595								0,735
PE3			0,750							0,819
PE4			0,744							0,791
PE2			0,715							0,759
PE1			0,637							0,722
SE4				0,720						0,716
SE3				0,667						0,642
SE2				0,655						0,693
SE5				0,553						0,567
BI3					0,738					0,828
BI2					0,715					0,776
BI1					0,647					0,704
BI4					0,602					0,721
ATT3						0,729				0,623
ATT4						0,698				0,650
ATT2						0,666				0,577
ATT1						0,609				0,575
EE2							0,809			0,806
EE1							0,680			0,619
EE3							0,607			0,512
FC2								0,833		0,788
FC3								0,672		0,554
FC1								0,637		0,636
SN3									0,814	0,799
SN2									0,784	0,727
SN1									0,548	0,522
Extraction Method: Principal Axis Factoring. Rotation Method: Varimax with Kaiser Normalization.										
a. Rotation converged in 8 iterations.										

5.4 Descriptive Results

This section provides a general overview of the most widely used descriptive statistics and provides a detailed explanation of the most common descriptive results such as frequency, measures of central tendency, and dispersion.

Table 5.14 presents the distribution of students who participated in this study according to gender, age, education level, years of computer experience, and ethnicity. The gender distribution shows there are more male students (59.4%) than female students (40.6%). This is reflective of the gender imbalance which skews the balance towards males as most females are not willing to take on the challenge of computer programming. On the age of students, most of the participating students in the study (74.7%) reported falling within the age range of 20-25 years old. On ethnicity, almost all students who participated in the study 247 (99.2%) were Africans. This is in fulfilment of the country's commitment to further reach out and empower the African communities with most of these students having a minimum of 0-5 years of computer experience. This is evident as most of them get exposed to using the computer during their first year in university. On the educational level of the students, most of the respondents were second year students while other levels show an even distribution.

Table 5-14: Demographic information of the students

Demographic Categories	**Frequency**	**Percent**	**Cumulative Percent**
Gender			
Male	148	59.4%	59.4%
Female	101	40.6%	100.0%
Age			
15-19	30	12.0%	12.0%
20-25	186	74.7%	86.7%
26-31	28	11.2%	98.0%
Above 31	5	2.0%	100.0%
Ethnicity			
African	247	99.2%	99.2%
Colored	1	0.4%	99.6%
Others	1	0.4%	100.0%
Years of Computer Experience			

0-2	107	43.0%	43.0%
3-5	102	41.0%	83.9%
6-8	20	8.0%	92.0%
9-11	10	4.0%	96.0%
Above 12	10	4.0%	100.0%
Education Level			
First Year	62	24.9%	24.9%
Second Year	124	49.8%	74.7%
Third Year	44	17.7%	92.4%
Fourth Year	19	7.6%	100.0%
Total	**249**	**100%**	

5.4.1 Gender Distribution

In terms of respondents' gender, a simple majority (59.4%) of respondents were male and the rest (40.6%) were female. As expected, males are more open to enrolling for information technology or computer programming related courses than their female counterparts as shown in Figure 5.2.

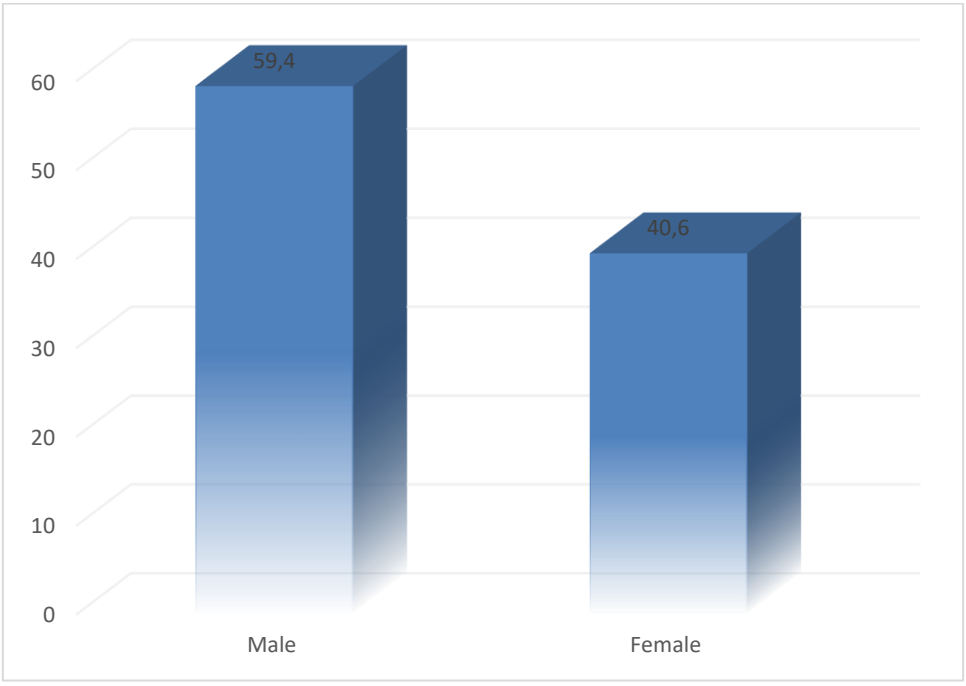

Figure 5-2: Gender distribution of respondents

5.4.2 Demographics by Age

In Figure 5.3, the results reveal that most respondents (74.7%) were found in the age group of 20-25 years. There seems to be an even distribution found in the age group of 15-19 years (12%) and 26-31 years (11.2%) of total respondents. Their young age makes it easy for them to be open to adopt technology like the hackathon for teaching and learning of computer programming.

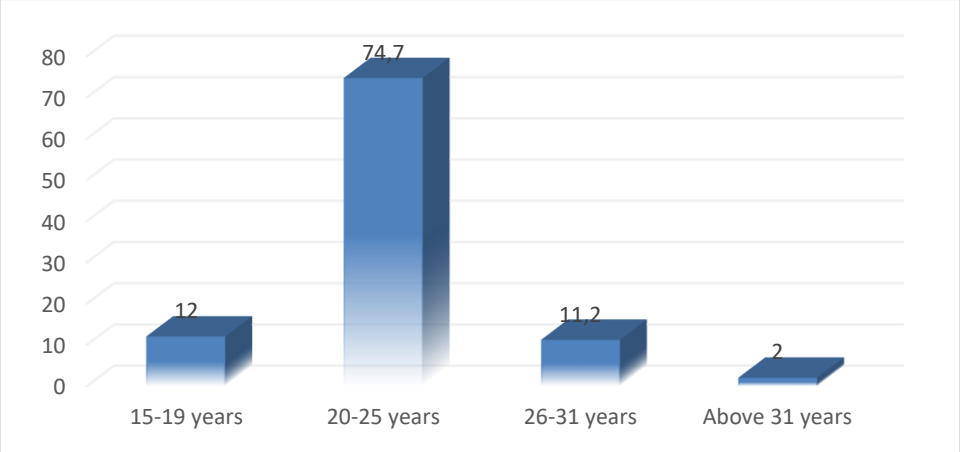

Figure 5-3: Age distribution of respondents

5.4.3 Demographics by Ethnicity

As shown in Figure 5.4, there are more African students (99.2%) than any other nationality. This could be due to location and the focus for which the institution was established to get closer to the roots of African communities.

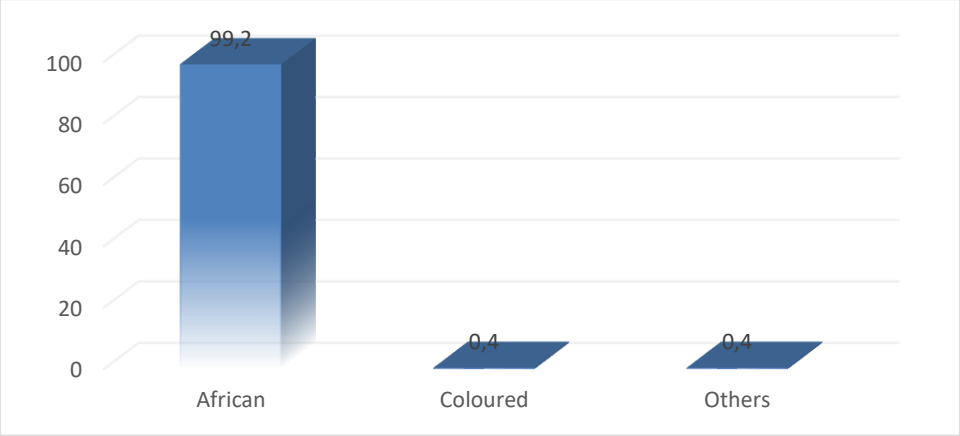

Figure 5-4: Ethnicity distribution of respondents

5.4.4 Years of computer experience

When examining the computer experience of the respondents, an overwhelmingly majority of respondents (84%) have computer experience between 0-5 years, whilst 8% have computer experience between 6 and 8 years, and 8% have computer experience between 9 and 12 years. This helps us to understand that there are more students who have access to the using computers and their applications which further translates to easier adoption of hackathon for teaching and learning in HE institutions.

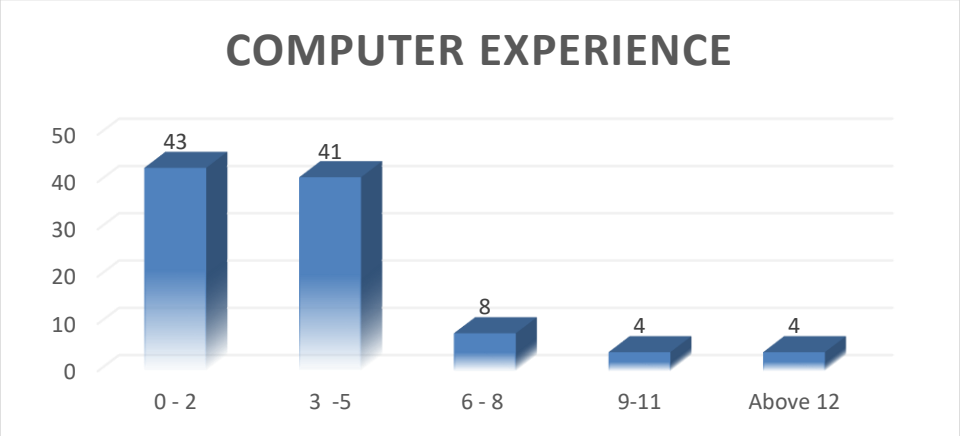

Figure 5-5: Years of computer experience of respondents

5.4.5 Education level

The result in figure 5.6 shows that half (49.8%) of the respondents are second year students followed by first year students (24.9%). Finally, third (17.7%) and fourth year (7.6%) students made up the remainder of the respondents from the study.

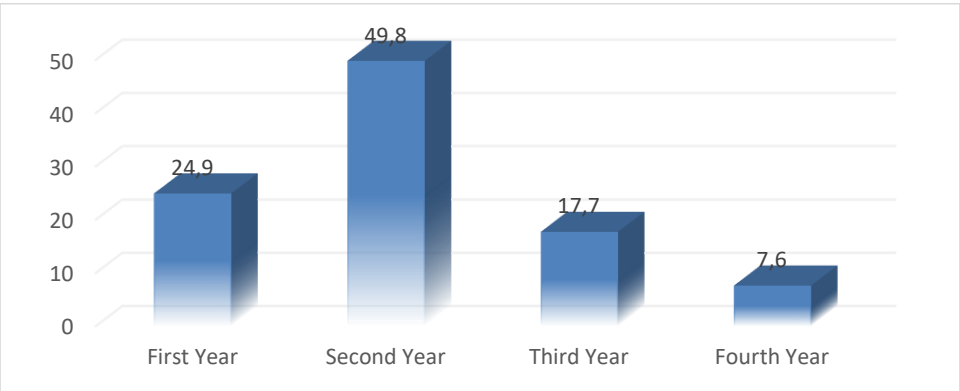

Figure 5-6: Education level distribution of respondents

5.4.6 Central Tendency and Dispersion

To determine our central tendency and dispersion, the mean and standard deviation was used to realise this purpose. The measurement scale of all factors consisted of forty-nine items, measured on a five-point scale. The mean and standard deviations obtained from the scales are presented in Table 5.15. The mean values of the items ranged from 3.14 to 3.84, while those of the standard deviation ranged from 0.50 to 0.85 and above. Therefore, the overall mean and standard deviation values respectively suggest an indication that all the ten factors influence the adoption and use of hackathon for teaching and learning of computer programming

Table 5-15: Central tendency and dispersion

Factors	N	Mean	Std. Deviation
Effort Expectancy	249	3,50	0,65
Perceived Usefulness	249	3,51	0,68
Relative Advantage	249	3,60	0,70
Performance Expectancy	249	3,84	0,70
Self-Efficacy	249	3,60	0,68
Behavioural Intention	249	3,66	0,75
Attitude	249	3,48	0,65
Facilitating Condition	249	3,14	0,85
Subjective Norm	249	3,26	0,73
Perceived Ease of Use	249	3,51	0,50

5.5 Inferential Statistics

The study conducted an inferential statistics analysis to confirm the development of the research hypothesis. To make predictions based on data and to draw conclusions about the data collected from the survey, this section presents the results of the inferential statistics which includes a one sample t-test, Pearson correlation and multiple regression tests.

5.5.1 One Sample T-test

The one-sample t-test is a statistical hypothesis test used to determine whether an unknown population mean is different from a specific value. The t-test was conducted in the current study to be certain participants had a defined opinion/perception other than neutral to ascertain whether they agreed or disagreed with the constructs. This was realised by comparing the sample mean of the survey result with a known sample population mean of three indicating a neutral response from the population.

Hypotheses:

- H_0: $\mu = 3$ (Participants do not have a defined opinion/perception for each proposed construct)
- H_1: $\mu \neq 3$ (Participants have a defined opinion/perception for each proposed construct)

The result of the comparison is shown in Tables 5.16 to 5.35.

5.5.1.1 Perceived Usefulness

- H_0: μPerceived usefulness = 3 (Participants do not have a defined opinion/perception)
- H_1: μPerceived usefulness ≠ 3 (Participants have a defined opinion/perception)

One sample t-test was run to assess if the perceived usefulness of the students who participated in the study differ significantly to the population mean of the students. The descriptive statistics from Table 5.16 showed that 3.5049 is the average PU of the sample, and 0.67644 is the standard deviation, indicating positive perceptions regarding all items on perceived usefulness. The results reveal a significant difference in the PU of students in comparison to the population mean t (248) = 11.88, p <=0.05).

Table 5-16: PU one sample statistics

Factors	N	Mean	Std. Deviation	Std. Error Mean
Perceived Usefulness	249	3,5049	0,67644	0,04287

Table 5-17: PU one sample test value

	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Perceived Usefulness	11,882	248	0.000	0,50937	0,4249	0,5938

Since p-value < α, H_0 is rejected.

The average of the perceived usefulness (PU) population is not equal to the μ0. In other words, the difference between the average of the PU and μ0 is big enough to be statistically significant. Hence, the average PU of the students is significantly different from the average population mean of the students. The sample of the mean responses significantly differ.

5.5.1.2 Relative Advantage

- H_0: μRelative advantage = 3 (Participants do not have a defined opinion/perception)
- H_1: μRelative advantage ≠ 3 (Participants have a defined opinion/perception)

One sample T-Test was run to assess if the relative advantage of the students who participated in the study differed significantly from the population mean of the students. The descriptive statistics from Table 5.16 showed that 3.5928 is the average RA of the sample, and 0,70146 is the standard deviation, indicating positive perceptions regarding all items on relative advantage. The results reveal a significant difference in the RA of students in comparison to the population mean t (248) = 13.34, p <=0.05).

Table 5-18: RA one sample statistics

Factors	N	Mean	Std. Deviation	Std. Error Mean
Relative Advantage	249	3,5928	0,70146	0,04445

Table 5-19: RA one sample test value

	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Relative Advantage	13,335	248	0,000	0,59277	0,5052	0,6803

Since p-value < α, H_0 is rejected.

The average of relative advantage (RA) of the population is not equal to the μ0. In other words, the difference between the average of the RA and μ0 is big enough to be statistically significant. Hence, the average RA of the students is significantly different from the average population mean of the students. The sample of the mean responses significantly differ.

5.5.1.3 Performance Expectancy

- H_0: μPerformance expectancy = 3 (Participants do not have a defined opinion/perception)
- H_1: μPerformance expectancy ≠ 3 (Participants have a defined opinion/perception)

Regarding the measurement of performance expectancy, one sample T-Test was run to assess if the performance expectancy of the students who participated in the study differed significantly

from the population mean of the students. The descriptive statistics from Table 5.16 show that 3,8394 is the average PE of the sample, and 0,70124 is the standard deviation, indicating positive perceptions regarding all items on PE. The results reveal a significant difference in the PE of students in comparison to the population mean t (248) = 18.89, p <=0.05).

Table 5-20: PE one sample statistics

Factors	N	Mean	Std. Deviation	Std. Error Mean
Performance Expectancy	249	3,8394	0,70124	0,04444

Table 5-21: PE one sample test value

	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Performance Expectancy	18,888	248	0,000	0,83936	0,7518	0,9269

Since p-value < α, H_0 is rejected.

The average of performance expectancy (PE) of the population is not equal to the μ0. In other words, the difference between the average of the PE and μ0 is big enough to be statistically significant. Hence, the average PE of the students is significantly different from the average population mean of the students. The sample of the mean responses significantly differ.

5.5.1.4 Self-Efficacy

- H_0: μSelf-efficacy = 3 (Participants do not have a defined opinion/perception)
- H_1: μSelf-efficacy ≠ 3 (Participants have a defined opinion/perception)

One sample T-Test was run to assess if the self-efficacy of the students who participated in the study differed significantly from the population mean of the students. The descriptive statistics from Table 5.16 showed that 3,6034 is the average SE of the sample, and 0,67695 is the standard deviation, indicating positive perceptions regarding all items on relative advantage. The results reveal a significant difference in the SE of students in comparison to the population mean t (248) = 14.07, p <=0.05).

Table 5-22: SE one sample statistics

Factors	N	Mean	Std. Deviation	Std. Error Mean
Self-Efficacy	249	3,6034	0,67695	0,0429

Table 5-23: SE one sample test value

	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Self-Efficacy	14,066	248	0,000	0,60341	0,5189	0,6879

Since p-value < α, H_0 is rejected.

The average of self-efficacy (SE) of the population is not equal to the μ0. In other words, the difference between the average of the SE and μ0 is big enough to be statistically significant. Hence, the average SE of the students is significantly different from the average population mean of the students. The sample of the mean responses significantly differ.

5.5.1.5 Behavioural Intention

- H_0: μBehavioural intention = 3 (Participants do not have a defined opinion/perception)
- H_1: μBehavioural intention ≠ 3 (Participants have a defined opinion/perception)

Regarding the measurement of behavioural intention, one sample T-Test was run to assess if the behavioural intention of the students who participated in the study differed significantly from the population mean of the students. The descriptive statistics from Table 5.16 showed that 3,6576 is the average BI of the sample, and 0,74663 is the standard deviation, indicating positive perceptions regarding all items on BI. The results reveal a significant difference in the BI of students in comparison to the population mean t (248) = 13.89, p <=0.05).

Table 5-24: BI one sample statistics

Factors	N	Mean	Std. Deviation	Std. Error Mean
Behavioural Intention	249	3,6576	0,74663	0,04732

Table 5-25: BI one sample test value

	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Behavioural Intention	13,899	248	0,000	0,65763	0,5644	0,7508

Since p-value < α, H_0 is rejected.

The average of behavioural intention (BI) of the population is not equal to the μ0. In other words, the difference between the average of the BI and μ0 is big enough to be statistically significant. Hence, the average BI of the students is significantly different from the average population mean of the students. The sample of the mean responses significantly differ.

5.5.1.6 Attitude

- H_0: μAttitude = 3 (Participants do not have a defined opinion/perception)
- H_1: μAttitude ≠ 3 (Participants have a defined opinion/perception)

One sample T-Test was run to assess if the attitude of the students who participated in the study differed significantly from the population mean of the students. The descriptive results from Table 5.16 showed that 3,4829 is the average attitude of the sample, and 0,65451 is the standard deviation, indicating positive perceptions regarding all items on attitude. The results reveal a significant difference in the attitude of students in comparison to the population mean t (248) = 11.64, p <=0.05).

Table 5-26: Attitude one sample statistics

Factors	N	Mean	Std. Deviation	Std. Error Mean
Attitude	249	3,4829	0,65451	0,04148

Table 5-27: Attitude one sample test value

	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Attitude	11,643	248	0,000	0,48293	0,4012	0,5646

Since p-value < α, H_0 is rejected.

The average of behavioural intention (BI) population is not equal to the μ0. In other words, the difference between the average of the BI and μ0 is big enough to be statistically significant. Hence, the average ATT of the students is significantly different from the average population mean of the students. The sample of the mean responses significantly differ.

5.5.1.7 Effort Expectancy

- H_0: μEffort expectancy = 3 (Participants do not have a defined opinion/perception)
- H_1: μEffort expectancy ≠ 3 (Participants have a defined opinion/perception)

One sample T-Test was run to assess if the effort expectancy of the students who participated in the study differed significantly from the population mean of the students. The descriptive statistics from Table 5.16 showed that 3,4950 is the average effort expectancy of the sample, and 0,64969 is the standard deviation, indicating positive perceptions regarding all items on effort expectancy and influences the adoption and use of hackathon for teaching and learning of computer programming. The results reveal a significant difference in the effort expectancy of students in comparison to the population mean t (248) = 12.02, p <=0.05).

Table 5-28: EE one sample statistics

Factors	N	Mean	Std. Deviation	Std. Error Mean
Effort Expectancy	249	3,495	0,64969	0,04117

Table 5-29: EE one sample test value

	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Effort Expectancy	12,022	248	0,000	0,49498	0,4139	0,5761

Since p-value < α, H_0 is rejected.

The average of effort expectancy (EE) of the population is not equal to the μ0. In other words, the difference between the average of the EE and μ0 is big enough to be statistically significant. The observed standardised effect size is large (0.76). That indicates that the magnitude of the difference between the average and μ0 is large. Hence, the average EE of the students is significantly different from the average population mean of the students. The sample of the mean responses significantly differ.

5.5.1.8 Facilitating Condition

- H_0: μFacilitating conditions = 3 (Participants do not have a defined opinion/perception)
- H_1: μFacilitating conditions ≠ 3 (Participants have a defined opinion/perception)

One sample T-Test was run to assess if the facilitating conditions of the students who participated in the study differed significantly from the population mean of the students. The descriptive statistics from Table 5.4 showed that 3,1432 is the average facilitating conditions of the sample, and 0,84535 is the standard deviation indicating positive perceptions regarding all items on facilitating conditions. However, the results reveal a significant difference in the facilitating conditions of students in comparison to the population mean t (248) = 2.67, p >=0.05).

Table 5-30: FC one sample statistics

Factors	N	Mean	Std. Deviation	Std. Error Mean
Facilitating Condition	249	3,1432	0,84535	0,05357

Table 5-31: FC one sample test value

	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Facilitating Condition	2,674	248	0,008	0,14324	0,0377	0,2488

Since p-value < α, H_0 is rejected.

The average of FC population is not equal to the μ0. In other words, the difference between the average of the FC and μ0 is big enough to be statistically significant. The observed standardised effect size is small (0.17). That indicates that the magnitude of the difference between the average FC and μ0 is small. Hence, average facilitating conditions of the students is significantly different from the average population mean of the students. The sample of the mean responses does not significantly differ from the population.

5.5.1.9 Subjective Norm

- H_0: μSubjective norm = 3 (Participants do not have a defined opinion/perception)
- H_1: μSubjective norm ≠ 3 (Participants have a defined opinion/perception)

Regarding the measurement of subjective norm on a five-point scale, one sample T-Test was run to assess if the subjective norm of the students who participated in the study differed significantly from the population mean of the students. The descriptive statistics from Table 5.4 showed that 3,2637 is the average for facilitating conditions of the sample, and 0,73236 is the standard deviation, indicating positive perceptions regarding all items on facilitating conditions. However, the results reveal no significant difference in the subjective norm of students in comparison to the population mean t (248) = 2.67, p <=0.05).

Table 5-32: SN one sample statistics

Factors	N	Mean	Std. Deviation	Std. Error Mean
Subjective Norm	249	3,2637	0,73236	0,04641

Table 5-33: SN one sample test value

	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Subjective Norm	5,682	248	0,000	0,26372	0,1723	0,3551

Since p-value < α, H_0 is rejected.

The average of SN population is not equal to the μ0. In other words, the difference between the average of the SN and μ0 is big enough to be statistically significant. The observed standardised effect size is medium (0.36). That indicates that the magnitude of the difference between the average and μ0 is medium. Hence, the average SN of the students is significantly different from the average population mean of the students.

5.5.1.10 Perceived Ease of Use

- H_0: μPerceived ease of use = 3 (Participants do not have a defined opinion/perception)
- H_1: μPerceived ease of use ≠ 3 (Participants have a defined opinion/perception)

One sample T-Test was run to assess if the perceived ease of use of the students who participated in the study differed significantly from the population mean of the students. The descriptive statistics from Table 5.4 showed that 3,5047 is the average PEOU of the sample, and 0,46238 is the standard deviation, indicating positive perceptions regarding all items on perceived

ease of use. The results reveal a significant difference in the PEOU of students in comparison to the population mean t (248) = 17.22, p <=0.05).

Table 5-34: PEOU one sample statistics

Factors	N	Mean	Std. Deviation	Std. Error Mean
Perceived Ease of Use	249	3,5047	0,46238	0,0293

Table 5-35: PEOU one sample test value

	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Perceived Ease of Use	17,223	248	0,000	0,50469	0,447	0,5624

Since p-value < α, H_0 is rejected.

The average of SN population is not equal to the μ0. In other words, the difference between the average of the SN and μ0 is big enough to be statistically significant. The observed standardised effect size is large (1.09). That indicates that the magnitude of the difference between the average and μ0 is large. Hence, the average PEOU of the students is significantly different from the average population mean of the students. This shows that the sample does not represent the population.

5.5.2 Pearson Correlation Analysis

The Pearson correlation coefficient measures the strength of linear association between two variables, indicating the direction (either positive or negative) and strength of the relationship (Mukaka, 2012; Schober et al., 2018; Sedgwick, 2012). Correlation strength can be measured using Schober et al. (2018) guide, which states that from 0.00-.10 are considered “negligible”, from 0.10-0.39 are considered “weak”, from .40-.69 are considered “moderate”, from .70-.89 are considered “strong” and from 0.90-1.0 are considered “very strong”. Using the Pearson product-moment correlation coefficient, the relationship between the measures of hackathon adoption was investigated. Results from Table 5.36 indicate that the factors PU ($r = 0.615$), RA ($r = 0.657$), PE ($r = 0.597$), SE ($r = 0.660$), ATT ($r = 0.440$), EE ($\rho < 0.520$) and SN ($r = 0.441$) have a moderate positive relationship with BI ($\rho < 0.001$) while FC ($r = 0.357$), has a weak positive relationship with BI ($\rho < 0.001$) to adopt hackathon.

Table 5-36: Pearson correlation coefficient

		PU	RA	PE	SE	BI	ATT	EE	FC	SN
PU	Pearson Correlation	--								
RA	Pearson Correlation	.707**	--							
	Sig. (2-tailed)	0,000								
PE	Pearson Correlation	.600**	.588**	--						
	Sig. (2-tailed)	0,000	0,000							
SE	Pearson Correlation	.545**	.673**	.458**	--					
	Sig. (2-tailed)	0,000	0,000	0,000						
BI	Pearson Correlation	.615**	.657**	.597**	.660**	--				
	Sig. (2-tailed)	0,000	0,000	0,000	0,000					
ATT	Pearson Correlation	.475**	.405**	.545**	.442**	.440**	--			
	Sig. (2-tailed)	0,000	0,000	0,000	0,000	0,000				
EE	Pearson Correlation	.513**	.521**	.602**	.440**	.520**	.380**	--		
	Sig. (2-tailed)	0,000	0,000	0,000	0,000	0,000	0,000			
FC	Pearson Correlation	.514**	.446**	.220**	.384**	.357**	.389**	.344**	--	
	Sig. (2-tailed)	0,000	0,000	0,000	0,000	0,000	0,000	0,000		
SN	Pearson Correlation	.484**	.499**	.338**	.466**	.441**	.363**	.319**	.392**	--
	Sig. (2-tailed)	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	

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

5.5.3 Multiple Regression Analysis

Multiple regression determines the relationship between a single dependent variable and multiple independent variables to explore the predictive ability of a set of independent variables on one continuous dependent measure (Rovai et al., 2013). Nine factors from the study were subjected to linear regression analysis to measure the success of the hackathon adoption model and estimate factors that influence hackathon use behaviour. The independent variables in the model for hackathon adoption are social norm, effort expectancy, facilitating condition, attitude, self-efficacy, perceived usefulness, performance expectancy, relative advantage. The dependent variable is behavioural intention to adopt hackathon.

5.5.3.1 Model Summary and ANOVA

Using enter method, Table 5.38 displays the standard regression test summary of ANOVA where a significant regression model emerged: F (8, 240) =43.16, p = .000 and p < 0.05, which shows

that the test is statistically significant. This suggests that the independent factors are significantly related to students' behavioural intention to adopt hackathon. The summary of the standard regression model in Table 5.37 represents multiple correlation values (R = 0.77). This shows how well some of the independent combined factors (SN, EE, FC, ATT, SE, PU, PE, and RA) related to participants' behavioural intention (dependent factor) to adopt hackathon. Moreover, the Adjusted R^2 = 0.58 suggests that all the independent factors combine contributed 59% of the variances in students' behavioural intention to adopt hackathon.

Table 5-37: Model summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.768[a]	0,59	0,576	0,48601

a. Predictors: (Constant), Subjective Norm, Effort Expectancy, Facilitating Condition, Attitude, Self-Efficacy, Perceived Usefulness, Performance Expectancy, Relative Advantage

Table 5-38: ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	81,56	8	10,195	43,161	.000[b]
	Residual	56,69	240	0,236		
	Total	138,251	248			

a. Dependent Variable: Behavioural Intention

b. Predictors: (Constant), Subjective Norm, Effort Expectancy, Facilitating Condition, Attitude, Self-Efficacy, Perceived Usefulness, Performance Expectancy, Relative Advantage

5.5.3.2 Coefficients

The regression analysis was able to determine the causal relationship between behavioural intention and eight constructs in the research model. Table 5.39 shows a summary of predictive factors in terms of significance values for each individual factor obtained from regression analysis. The regression test result indicates that attitude ($\beta = 0.008, \rho = 0.886$), effort expectancy ($\beta = 0.088, \rho = 0.112$), facilitating condition ($\beta = -0.033, \rho = 0.951$), and subjective norm $\beta = 0.049, \rho = 0.330$). Since $\rho > 0.05$ then they are not statistically significant. This implies that students' behavioural intention to adopt hackathon is not influenced by attitude, facilitating condition, social norm, and effort expectancy. Moreover, perceived usefulness ($\beta = 0.141, \rho = 0.036$), relative advantage ($\beta = 0.142, \rho = 0.045$), performance expectancy ($\beta = 0.205, \rho = 0.002$) and self-efficacy ($\beta = 0.330, \rho = 0.000$). Since $\rho < 0.05$, then they are statistically significant. This indicates perceived usefulness, relative advantage, performance expectancy,

and self-efficacy are the variables that validate the conceptual framework that has a positive influence on students' adoption of hackathon.

Table 5-39: Co-efficients[a]

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-0,119	0,22		-0,543	0,588		
	Perceived Usefulness	0,156	0,074	0,141	2,11	0,036	0,382	2,617
	Relative Advantage	0,151	0,075	0,142	2,015	0,045	0,343	2,917
	Performance Expectancy	0,218	0,069	0,205	3,167	0,002	0,408	2,45
	Self-Efficacy	0,364	0,065	0,33	5,613	0	0,494	2,023
	Attitude	0,009	0,061	0,008	0,144	0,886	0,593	1,687
	Effort Expectancy	0,101	0,063	0,088	1,595	0,112	0,567	1,763
	Facilitating Condition	-0,003	0,046	-0,003	-0,061	0,951	0,625	1,6
	Subjective Norm	0,050	0,051	0,049	0,976	0,33	0,671	1,49
a. Dependent Variable: Behavioural Intention								

5.6 Hypotheses Testing and Conceptual Model Revision

The results in Table 5.22 summarises the hypotheses that were presented in chapter three by showing whether the research hypotheses are supported or rejected. Eight research hypotheses were tested to examine whether the independent variables significantly explained the dependent variables using the Pearson correlation and regression analysis. This was because the perceived ease of use was dropped during factor analysis. The results of the correlation and regression help to explain the direction and strength of a relationship as well as build the model and predict responses to answer our research questions 3.

The regression analysis results for value for perceived usefulness($\beta = 0.141, \rho = 0.036$), relative advantage ($\beta = 0.142, \rho = 0.045$), performance expectancy ($\beta = 0.205, \rho = 0.002$) and self-efficacy ($\beta = 0.330, \rho = 0.000$) show that these constructs positively influenced hackathon adoption for teaching and learning of computer programming. Furthermore, attitude ($\beta = 0.008, \rho = 0.886$), effort expectancy ($\beta = 0.088, \rho = 0.112$), facilitating condition ($\beta = -0.033, \rho = 0.951$), and subjective norm $\beta = 0.049, \rho = 0.330$) are found not to be statistically significant and therefore do not influence behavioural intention to adopt hackathon for teaching and learning of computer programming. However, the findings show that perceived usefulness, relative advantage, performance expectancy, and self-efficacy have positive influence on adoption of hackathon. Findings of the correlation analysis revealed that PU ($r = 0.615$), RA ($r = 0.657$), PE

($r = 0.597$), SE ($r = 0.660$), ATT ($r = 0.440$), EE ($\rho < 0.520$) and SN ($r = 0.441$) have a moderately positive relationship with BI ($\rho < 0.001$). FC ($r = 0.357$), has a weak positive relationship with BI ($\rho < 0.001$) to adopt hackathon for teaching and learning of computer programming.

The combination of outcome of the tests performed in confirming the hypothesis show perceived usefulness, relative advantage, performance expectancy, self-efficacy, attitude, facilitating condition, subjective norm, and effort expectancy have positive relationships with behavioural intention to adopt hackathon. However, from the results of the regression analysis, four of the variables (perceived usefulness, relative advantage, performance expectancy, and self-efficacy) are found to have a positive and significant influence on adoption of hackathon for teaching and learning of computer programming while attitude, facilitating condition, social norm, and effort expectancy do not influence behavioural intention to adopt hackathon for teaching and learning of computer programming. The empirical testing of the conceptual hackathon model proposed in section 3.5 fulfils research objective 3 to evaluate the hackathon adoption model through investigating the different hypotheses developed and the new resulting model which is summarised in Table 5.40 and presented in Figure 5.7.

Table 5-40: Research hypothesis outcome

H No	Proposed Hypothesis	Result
H_{R1}	Performance expectancy has a positive influence on behavioural intentions to adopt hackathon	Supported
H_{C1}	Performance expectancy has a moderate positive relationship with behavioural intentions to adopt hackathon	Supported
H_{R2}	Effort expectancy has a positive influence on behavioural intentions to adopt hackathon	Not Supported
H_{C2}	Effort expectancy has a moderate positive relationship with behavioural intentions to adopt hackathon	Supported
H_{R3}	Facilitating condition has a positive influence on behavioural intentions to adopt hackathon	Not Supported
H_{C3}	Facilitating condition has a weak positive relationship with behavioural intentions to adopt hackathon	Supported
H_{R4}	Attitude has a positive influence on behavioural intentions to adopt hackathon	Not Supported
H_{C4}	Attitude has a moderate positive relationship with behavioural intentions to adopt hackathon	Supported
H_{R5}	Subjective norm has a positive influence on behavioural intentions to adopt hackathon	Not Supported
H_{C5}		Supported

	Subjective norm has a moderate positive relationship with behavioural intentions to adopt hackathon	
H_{R6}	Perceived usefulness has a positive influence on behavioural intentions to adopt hackathon	Supported
H_{C6}	Perceived usefulness has a moderate positive relationship with behavioural intentions to adopt hackathon	Supported
H_{R7}	Perceived ease of use has a positive influence on behavioural intentions to adopt hackathon	Not Supported
H_{C7}	Perceived ease of use has a moderate positive relationship with behavioural intentions to adopt hackathon	Not Supported
H_{R8}	Relative advantage has a positive influence on behavioural intentions to adopt hackathon	Supported
H_{C8}	Relative advantage has a moderate positive relationship with behavioural intentions to adopt hackathon	Supported
H_{R9}	Self-efficacy has a positive influence on behavioural intentions to adopt hackathon	Supported
H_{C9}	Self-efficacy has a positive influence on behavioural intentions to adopt hackathon	Supported

The outcome of the research hypothesis is presented in a final conceptual framework presented in Figure 5.7.

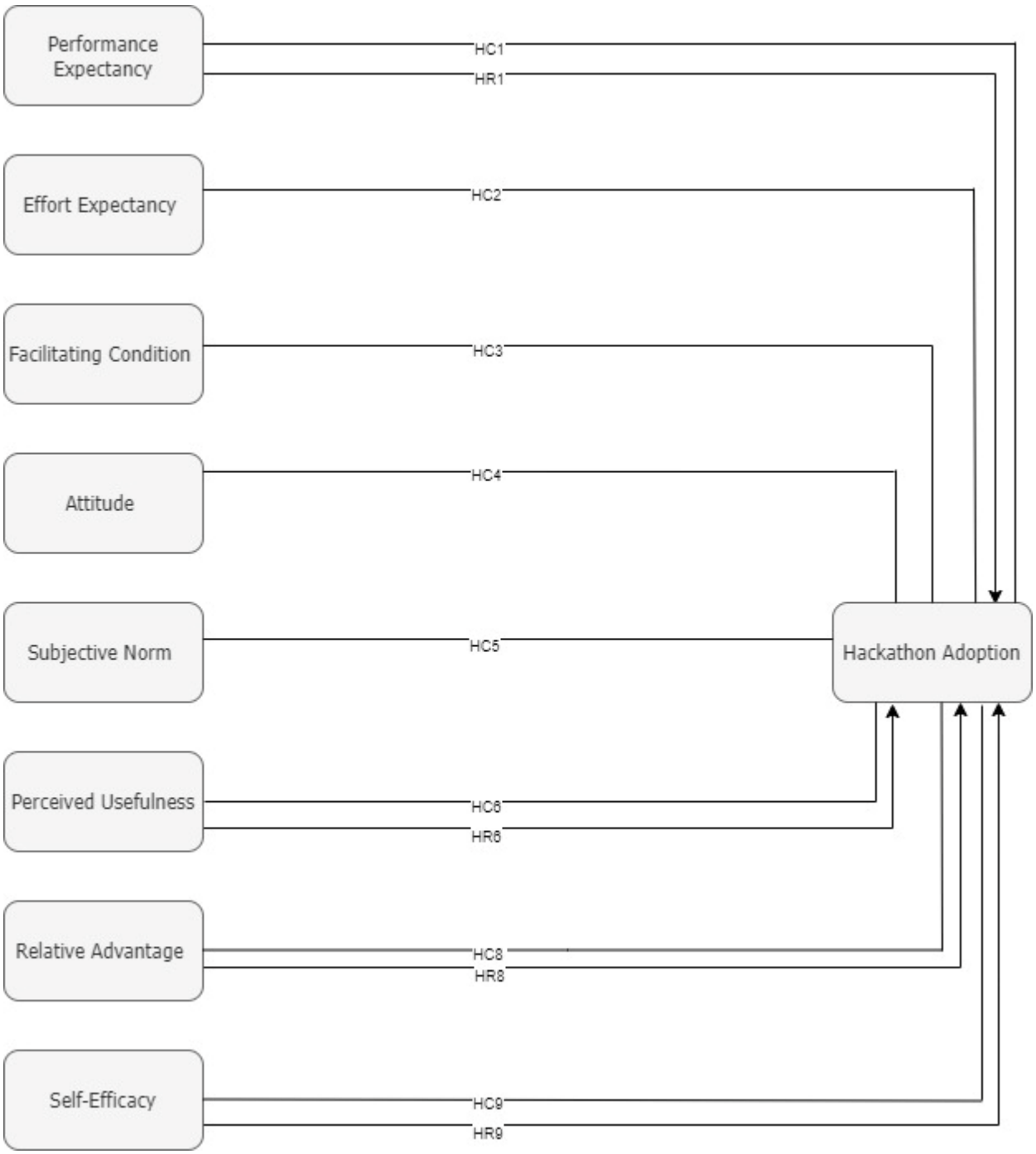

Figure 5-7: Final hackathon adoption framework

5.7 Chapter Summary

This chapter has reported on the empirical results obtained from the analysis of the primary data collected. Descriptive results were presented starting with demographic results and the inferential results were achieved using exploratory factor analysis, t-test, correlations, and regression results. The results of the descriptive statistics indicate most participant are Africans whose age

range falls between 20-25 years old with years of computer experience between 0-5 years. A simple majority of the participants are second year students who are females. The mean and standard deviation values respectively suggest that all the ten factors influence the adoption and use of hackathon for teaching and learning of CP. The results of the t-test reveal that the measurement scale of items indicates that there are positive perceptions regarding all items which indicates the items influence the adoption and use of hackathon for teaching and learning of CP. The results of the reliability test proved the instruments were reliable.

The factor analysis performed revealed the nine-factor structure has a KMO of 0.931 and a significant Bartlett's test of sphericity ($p < 0.01$). This indicates sufficient sampling adequacy and correlation between items. These nine factors were analysed for further testing of our hypotheses. The reliability of the factors was high with Cronbach's α greater than 0.7. The t-test measured and compared with 3 to show if people had a perception and indicated participants had a perception other than neutral. The results of the regression analysis showed that only four factors: perceived usefulness, relative advantage, performance expectancy, and self-efficacy are important and influence hackathon adoption for teaching and learning of computer programming while effort expectancy, facilitating conditions, subjective norm, and attitude were found not to influence behavioural intention to adopt hackathon for teaching and learning of computer programming.

Although some of the factors (EE, FC, ATT, and SN) were found not to influence behavioural intention to adopt hackathon. The correlation test shows that these factors have a significant relationship with behavioural intention to adopt hackathon. While FC has a weak positive relationship with behavioural intention to adopt hackathon, PE, EE, ATT, SN, PU, PEOU, RA, and SE have a moderate positive relationship with behavioural intention to adopt hackathon. The combination of the test results enables the development of the final model as presented in Figure 5.7.

CHAPTER 6 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

The focus of the study was to develop a model of the factors that influence hackathon adoption for teaching and learning of CP. At the core of the study was the poor academic performance of students in computer programming courses attributed to several factors which the study sought to address by proposing the hackathon as an alternative approach for teaching and learning of CP. Subsequently, this chapter discusses the study, the findings of the study, concludes, and makes recommendations for the study. The chapter also compares the results with literature, highlights possible limitations of this research, discusses the contributions of the study to policy, practice, and theory, summarises the thesis and provides suggestions for future research.

The following research questions was addressed:

- What are the factors that influence hackathon adoption for teaching and learning of CP?

This was further translated into the following research sub-questions and achieved through the following objectives:

- Research Question 1: Which theories can help to understand the adoption of hackathon for teaching and learning of computer programming?
- Research Objective 1: To identify relevant theories that can be applied to examine factors that influence hackathon adoption for teaching and learning computer programming.

A comprehensive literature review of technology adoption theories and models was done in chapter three. The most notable theories of technology adoption theories identified includes Technology Adoption Model (TAM), Diffusion of Innovation (DOI), Theory of Planned Behaviour (TPB), Technology, Organisation and Environment (TOE), Decomposed Theory of Planned Behaviour Decomposed –TPB, etc. Technology adoption refers to the choices an individual makes in adopting and accepting or otherwise rejecting new technologies. These theories were chosen because they were suitable to provide insight into how hackathon is adopted and further assists to describe the acceptance and adoption of new technologies by individuals. The review of the models and theories helped in determining the factors that would make up the hackathon conceptual model that would be tested for further analysis.

- Research question 2: How can the factors that explain hackathon adoption be shaped into a conceptual model?

- Research objective 2: To design an integrated conceptual model of the factors that influence hackathon adoption for teaching and learning computer programming.

Grounded in the technology adoption literature and the analysis of research question 1, the study combined different theoretical frameworks to develop the hackathon conceptual model presented in chapter three. Content analysis was applied to the selected articles using defined criteria to derive themes that explain the data collected by bringing together similar data within a framework of certain factors. These factors were interpreted by arranging them in a way that readers can understand through the systematic classification process of coding and identifying themes or patterns. The factors were categorised based on their significance, non-significance, and observed frequencies while further analysis was performed to arrive at the identified factors (Performance Expectancy, Perceived Usefulness, Relative Advantage and Self-Efficacy, Behavioural Intention, Relative Advantage, Effort Expectancy, Social Norm, and Facilitating Condition) to be used for the proposed hackathon adoption model in section 3.4 while the hypothesis was developed from the conceptual model in section 3.5.

- Research Question 3: How can the hackathon adoption model be tested empirically?
- Research Objective 3: To evaluate and test the hackathon adoption model through investigating the different hypotheses developed

To test the hackathon conceptual model designed from research question 2, descriptive and inferential statistics was performed in chapter five on the data collected to validate the model. The descriptive statistics employed were frequency distribution, central tendency (mean, median, mode), and dispersion (variance) which allowed the study to understand the distribution of the respondents of the survey. Based on the nature of the research question and the types of variables being analysed, the inferential statistics used for the current study were the t-test, factor analysis, correlation, and regression analysis to help the researcher conduct research with representative samples to draw inferences about the populations from which the samples were drawn because it would not be feasible to collect data from the entire population.

- Research Question 4: What recommendations can be suggested from the knowledge of the factors that influence the adoption of hackathon for teaching and learning of computer programming?
- Research Objective 4: To make recommendations on the factors that influence hackathon adoption based on the findings of the current study

Based on the outcomes of the final hackathon adoption model, the model is useful in guiding and supporting classroom-based or institution-based changes that seek to implement and adopt hackathon in the context of teaching and training to increase academic achievement for all

students. Also, further investigation on the influence of demographics is recommended for future research to investigate the influence of different age groups and gender differences.

6.2 Factors influencing hackathon adoption for teaching and learning of CP

To answer the main research question, the second and third research questions sought to determine the factors influencing hackathon adoption for teaching and learning of computer programming which was addressed by a quantitative approach. In testing the research model, the t-test measured and compared with three (neutral) to show if people had a perception. The T-test results indicated participants had a perception other than neutral.

The correlation analysis reveal that PU ($r = 0.615$), RA ($r = 0.657$), PE ($r = 0.597$), SE ($r = 0.660$), ATT ($r = 0.440$), EE ($\rho < 0.520$) and SN ($r = 0.441$) have a positive relationship with BI ($\rho < 0.001$) while FC ($r = 0.357$), has a weak positive relationship with BI ($\rho < 0.001$) to adopt hackathon. This finding suggests that perceived usefulness, relative advantage, performance expectancy, self-efficacy, attitude, facilitating condition, subjective norm, and effort expectancy have a moderate positive relationship with behavioural intention to adopt hackathon for teaching and learning of computer programming while facilitating conditions has a weak positive relationship with behavioural intention to adopt hackathon for teaching and learning of computer programming. Furthermore, the regression analysis result for value for perceived usefulness ($\beta = 0.141, \rho = 0.036$), relative advantage ($\beta = 0.142, \rho = 0.045$), performance expectancy ($\beta = 0.205, \rho = 0.002$) and self-efficacy ($\beta = 0.330, \rho = 0.000$). show that these attributes positively influenced hackathon adoption for teaching and learning of computer programming. Findings also show attitude ($\beta = 0.008, \rho = 0.886$), effort expectancy ($\beta = 0.088, \rho = 0.112$), facilitating condition ($\beta = -0.033, \rho = 0.951$), and subjective norm $\beta = 0.049, \rho = 0.330$) are not statistically significant and therefore do not influence hackathon adoption for teaching and learning of computer programming. This study found attitude, facilitating condition, social norm, and effort expectancy do not influence behavioural intention to adopt hackathon. However, the findings show that perceived usefulness, relative advantage, performance expectancy, and self-efficacy have a positive influence on adoption of hackathon.

The combination of outcome of the tests performed in confirming the hypothesis show perceived usefulness, relative advantage, performance expectancy, self-efficacy, attitude, facilitating condition, subjective norm, and effort expectancy have positive relationships with behavioural intention to adopt hackathon. However, from the results of the regression analysis, four of the variables (perceived usefulness, relative advantage, performance expectancy, and self-efficacy) were found to have a positive and significant influence on the adoption of hackathon for teaching and learning of computer programming, while attitude, facilitating condition, social norm, and

effort expectancy do not influence behavioural intention to adopt hackathon for teaching and learning of computer programming. This is presented in Figure 6.1 which is suitable for studying hackathon adoption for teaching and learning of CP. Also, given the scarcity of research into the determinants of hackathon adoption from literature (Porras et al., 2019), the research model offers a suitable point of reference for future studies on hackathon adoption in HEI.

6.3 Comparison of Research Findings with Literature

This section summarises findings of the inferential results and compares them with the reviewed existing literature on the factors that influence the intention to adopt technologies.

6.3.1 Perceived Usefulness and Behavioural Intention

The study results indicate a significant and a positive relationship between perceived usefulness and adoption of hackathon. This corroborates previous research that perceived usefulness is a strong determinant of intention to adopt technologies (Abramson et al., 2015; Alharbi and Drew, 2014; Chang et al., 2012; Diop et al., 2019; Dumpit and Fernandez, 2017; Šumak et al., 2011). Ma and Liu (2004) found a strong relationship between PU and BI. This implies that students believe using hackathon like other system enhances their continuous intention to improve computer programming performance. However, contrary to other findings, PU was found not to have a very strong effect on the actual behaviour intention (Chen et al., 2017) which could be related to user attitudes which impacted on their perceived usefulness of the system.

6.3.2 Relative Advantage and Behavioural Intention

Relative advantage is the extent to which an innovation is seen as better than the idea it is replacing. Research has consistently found support for a relationship between relative advantage and technology adoption (Hussin and Noor, 2005; Ramdani et al., 2009; Shah Alam et al., 2011; Tan and Eze, 2008; Van Slyke et al., 2010). The study, however, found support for a significant relationship between relative advantage and hackathon adoption for teaching and learning of CP. These findings suggest that relative advantage is influential in the context of hackathons as one would expect given the prevalence of the relative advantage in adoption literature.

6.3.3 Performance Expectancy and Behavioural Intention

Previous research and studies report that PE is a strong predictor of intention to use new technologies, and very influential in the adoption of e-learning (Maduku, 2015; Moghavvemi et al., 2012; Rahi and Ghani, 2018; Rahi et al., 2018; Zahir and Gharleghi, 2015). Furthermore, the findings from this study indicate a significant relationship between performance expectancy and behavioural intention to use hackathon, thus confirming outcomes from previous studies where

most of the students think that using hackathon would improve their computer programming performance and help them accomplish their tasks faster. On the contrary, Attuquayefio and Addo (2014) report that the effect of PE on behavioural intentions to use ICT were statistically insignificant. Since the research confirmed the positive and strong influence of performance expectancy on hackathon adoption, it is important to note that benefits such as improving performance, saving time and money, and increasing the quality and quantity of learning would influence the intentions of students and academics to adopt and use hackathon.

6.3.4 Self-Efficacy and Behavioural Intention

Self-efficacy is an individual's judgment on their ability to perform a given task which is strongly influenced by his/her perseverance, motivation, and effort to perform the task (Abramson et al., 2015; Wood and Bandura, 1989; Wu et al., 2010). Previous studies showed that self-efficacy was an influential predictor of intention to adopt technology (Abramson et al., 2015; Al-Azawei and Lundqvist, 2015; Giannakos and Vlamos, 2013) which corroborates the findings from the study that self-efficacy has a significant influence on behavioural intention to adopt hackathon for teaching and learning of CP. Moreover, this outcome is based on learner's cognitive beliefs affecting their behaviour when using a technology, and in the study context, the technology refers to hackathon (Al-Azawei and Lundqvist, 2015; Wu et al., 2010).

6.3.5 Effort Expectancy and Behavioural Intention

Previous research and studies showed that effort expectancy was found to be a significant antecedent of intention to adopt new technologies (Alshehri et al., 2012; Alsheikh and Bojei, 2014; Attuquayefio and Addo, 2014; Gupta et al., 2008; Maduku, 2015; Moghavvemi et al., 2012; Rahi and Ghani, 2018; Rahi et al., 2018). Interestingly, the research confirmed there was no significant relationship between effort expectancy and students' behavioural intention to adopt hackathon. The finding also found support from literature where EE has no significant impact on users' intentions to adopt technologies (Amadin and Obienu, 2016; Ibrahim et al., 2018; Zahir and Gharleghi, 2015). A plausible explanation could be that student didn't find hackathon easy to use so they could have more time engage in other academic or non-academic related activities.

6.3.6 Subjective Norm and Behavioural Intention

Previous studies show that subjective norm is a robust predictor of intention to adopt new technologies (Abramson et al., 2015; Dumpit and Fernandez, 2017). Interestingly, this research confirmed there was no significant relationship between social norm and student's behavioural intention to adopt hackathon. This finding found support from literature indicating no significant influence between subjective norm and a user's intention to adopt technologies (Amadin and

Obienu, 2016; Ibrahim et al., 2018; Zahir and Gharleghi, 2015). SN can be used to characterise normative behaviour which can be defined as an individual's perception of others and his approval of hackathon if others view it as a positive activity for the individual. However, the individual can either approve or reject the innovation based on other people's opinion (Abramson et al., 2015). It could therefore be stated that the surveyed students perceive hackathon as not significant based on the opinion of their colleagues.

6.3.7 Facilitating Condition and Behavioural Intention

Previous studies empirically confirmed that facilitating conditions are significant antecedents of intention to adopt new technologies (Alalwan et al., 2018; Alshehri et al., 2012; Amadin and Obienu, 2016; Attuquayefio and Addo, 2014; Gupta et al., 2008; Ibrahim et al., 2018; Maduku, 2015; Mathieson, 1991 Venkatesh et al., 2003; Zahir and Gharleghi, 2015). Interestingly, the research found no significant relationship between facilitating condition and a student's behavioural intention to adopt hackathon. This finding was supported by Rahi and Ghani (2018) which found that facilitating conditions and user's intention to adopt technologies are not significant. A probable explanation could be that this insignificant relationship could be attributed to the fact that the required facilities in the case of hackathon (i.e. PC, internet access, Wi-Fi, learning facilities) are fundamental aspects for IT students to have a smooth, safe, and easy access to computer programming modules but these are not available (Alalwan et al., 2018).

6.3.8 Attitude and Behavioural Intention

Previous studies empirically confirmed that attitude was found to be a significant antecedent of intention to adopt new technologies (Alharbi and Drew, 2014; Amadin and Obienu, 2016; Chang et al., 2012; Chen et al., 2017; Diop et al., 2019; Maduku, 2014). Interestingly, the research found no significant relationship between attitude and student's behavioural intention to adopt hackathon. This finding was supported by Šumak et al. (2011) which revealed contrary to our expectations, the relationship between attitude and a user's intention to adopt technology is not significant. This is not consistent with other studies which found that users with a positive attitude towards technology services equally have a positive behavioural intention to use the services. Consistent with Alharbi and Drew (2014)**,** a probable explanation as to why attitude is insignificant is that the excitement and benefits of hackathon may not be well communicated and widely known among the students making it difficult for them to relate to hackathon**.** Another possible explanation for this outcome is that students may underestimate the role of hackathon and are overconfident about the use of the technology (Chen et al., 2017; Diop et al., 2019).

6.4 Originality of Research

The originality of this study is reflected in several ways. Previous studies have investigated the determinants of factors in two ways: factors that influence technology adoption, and factors that have a positive or negative relationship with technology adoption via the theoretical lens of the Technology Acceptance Model (TAM) and extended versions of TAM. These studies examined the relationship between the individual factors and attitudes towards technology adoption and usage (Abramson et al., 2015; Amadin and Obienu, 2016; Attuquayefio and Addo, 2014; Dumpit and Fernandez, 2017; Gupta et al., 2008; Ibrahim et al., 2018; Maduku, 2015).

The present study used a combination of theories develop the conceptual hackathon framework which was tested on students studying IT programming from the university of technology. The originality of this study, furthermore, lies in its ability to establish the predictors of hackathon adoption for teaching and learning of CP as well as separate the factors that influence hackathon adoption and the factors that have a relationship with hackathon adoption in the same model. This has extended the understanding of hackathon by proposing a model of hackathon adoption developed from a wide-ranging review of technology adoption literature to provide a high explanatory power of hackathon adoption and guide other researchers in identifying factors that can drive intention to adopt hackathon.

6.4.1 Contribution to Theory

Theoretically, the present study provides additional insight into the understanding of users' adoption of hackathon. It draws from the review of theoretical frameworks in section 3.2 to develop an integrated conceptual hackathon framework. The outcome of the conceptual framework provides a deeper understanding of the factors that influence people's adoption, as such, will direct future research. Also, the systematic review approach (chapter 3.4) used to select the models from the technology adoption theories to develop the hackathon conceptual model (chapter 3.5) to explain the factors influencing hackathon adoption is an addition to knowledge. The adaptation of constructs from a valuable and reliable technology model resulted in the development of a comprehensive and consistent model that identifies and analyses factors influencing the hackathon adoption. The systematic review employed in the study would be relevant to researchers and stakeholders by broadening insight into hackathon adoption and thereby enabling them to make right decisions regarding innovations.

6.4.2 Contribution to Policy

The findings of the study may inform the policy makers at the University of Technology and the Department of Higher Education and Training (DHET), Republic of South Africa in developing a

framework for information policies that address hackathon adoption and use for teaching and learning computer programming.

6.5 Research Limitations

Like any research that studies a new phenomenon, the study encountered some difficulties and limitations which include the following:

The national state of disaster and the lockdown due to the COVID-19 lockdown and restriction on movement affected the plans to conduct proper data collection and data analysis. The allocated time for data collection was only enough to collect information from the minimum possible participants to have a valid and reliable analysis and results. Besides, the data analyses used in the study are efficient to provide reliable and accurate results. However, further analyses using different methods could be carried out to confirm and validate the results.

Furthermore, the study could have overlooked and dropped certain construct while reviewing literature and rotating items that could help explain a significant portion of the variance associated with predicting the intention to utilise hackathon.

The sample population were ICT students from universities of technologies in South Africa. Since this was a survey, it is possible to generalise the result.

Finally, the study generalises only to ICT students. Since the participated organisations were educationally oriented, the outcomes of this research would suit similar profile organisations and will not represent all different organisations in South Africa. However, the novel conceptual model developed in this research would provide a valid and reliable model to explore and study technology adoption in other organisations with different contexts, and other countries in a wider context.

6.6 Recommendations

From the findings of the empirical study, theory and literature reviewed, the researcher makes recommendations on the following aspects: adoption and use of hackathon and factors influencing hackathon adoption for teaching and learning of computer programming.

6.6.1 Benefits of Hackathon

The study reviewed vast studies on the benefits of hackathon adoption. The findings include development of technical and soft skills, learning new things, effective collaboration, and

improvement to systems. The findings suggest that the level of adoption is increasingly becoming pervasive but not fully adopted by academics for teaching and learning purposes.

Recommendation 1: A framework for the integration of hackathon into the curriculum should be put in place.

6.6.2 Factors Influencing Hackathon Adoption

The third research question determined the factors influencing hackathon adoption for teaching and learning of computer programming. The findings showed that perceived usefulness, relative advantage, performance expectancy, and self-efficacy positively influence hackathon adoption for teaching and learning of computer programming.

Recommendation 2: Learning institutions should put in place policy (training; budget allocation; technical support; support from faculty/subject) directions on adoption and use of hackathon to create an environment to learn computer programming that will improve student's learning outcomes. The policies should provide clarity on standards, strategies, best practices, infrastructural acquisition, internet access, gender equity and data/information security.

Recommendation 3: Learning institutions should provide professional development programmes that are targeted towards improving the skills of academics. Such programmes should be innovative and directed towards enhancing competency of academics on the use of instructional technology. This will enhance their perception of the adoption of newer technologies to be better than other teaching methods that have been used to learn computer programming

6.7 Future Research

The current study examined the factors that influence hackathon adoption for teaching and learning of computer programming. The study was limited to students of computer programming students from South African selected universities, it is therefore recommended that further studies should be conducted in other traditional universities and universities of technologies in South Africa. This would offer a holistic view of how hackathon is applied in teaching CP in South Africa higher institutions and provide the baseline data necessary for planning in South African higher institutions.

Due to the problems related to the sample size resulting in a limited number of responses, future research should consider a larger sample size which would uncover new important relationships and/or confirm the ones already found and thus achieve greater result generalisability

Even though data were collected on demographics, further research should examine the influence of these variables to provide a better understanding of the potential users' perceptions to accept and adopt hackathon. Such investigations include comparing the influence of different age groups and gender differences

The study tested the conceptual model in the context of hackathons in higher education in South Africa. It will be interesting to see if the hackathon model is used as a frame of reference for future research in different contexts or countries where the political and economic environment is more stable to see whether the results will be the same.

The findings of the future research may prove useful in guiding and supporting classroom-based or institution-based changes that seek to implement and adopt hackathons in the context of teaching and training to increase academic achievement for all students.

6.8 Summary of the Chapters in the Thesis

Chapter one provides the background of ICTs and the evolution of computer programming languages and how it relates to the demand for skilled programmers leading to the problem at the core of the study, i.e., to identify the factors that influence the adoption of hackathon for teaching and learning of CP in HE institutions. The background to the research problem, the purpose of the study and the research questions were provided. The chapter also provided insight into the justification of the study, contribution to knowledge, and a brief description of the methodology. Finally, an outline of the structure of the thesis was provided.

Chapter two discusses the background of hackathon. The PRISMA method was applied to identify and analyse extensively literature on hackathon to explore trends from 2008 to 2020 to report on the contributions of hackathon to academic and social development and the challenges that have an impact on growth and development. The reviewed literature as obtained from primary and secondary sources that were identified by searching various databases such as IEEE, Google scholar, and EBSCOhost. The study found that, despite cross continent research on hackathons, the developed nations have more research outputs than developing nations. Understanding its adoption is crucial and timely. Hence, the justification of the study.

Chapter three reviewed various models and theories that are commonly used to study technology adoption. This is suitable to understand the factors that influence hackathon adoption. Identified theories are TAM, DOI, TPB, TAM 2, TAM 3, TOE, Decomposed –TPB, and UTAUT, etc. These theories were examined to investigate and determine the factors that would make up the conceptual model of hackathon adoption that would be tested empirically to build the final hackathon adoption model for teaching and learning of CP in HE institutions. Chapter three also

presented a synthesis of both empirical and theoretical literature based on the themes arising from the key variables derived from the technology adoption models and theories, such as performance expectancy, effort expectancy, social norm, facilitating conditions, behavioural intention, relative advantage, perceived usefulness, and perceived ease of use. These variables were used to develop the hackathon conceptual model from which the hypotheses is developed

Chapter four discussed the chosen research methodology, the Honeycomb method to guide the study with the collection and analysis of data that would be done in chapter five. It discussed research philosophy, research approach, research strategy, research design, data collection, and the data analysis techniques employed by the study. The detailed research design discussed the population of the study: sampling procedures; data collection procedures; data analysis; reliability and validity and ethical aspects of the research. The positivism (epistemology) was found appropriate as the philosophical foundation for the study as it provided for an objective view (ontology) and a value free (axiology) response from the respondent. The deductive approach which employs a quantitative strategy was adopted for this study. Furthermore, an experimental and cross-sectional research design was used because it is easily quantified or measured and was inexpensive and easy to conduct. The questionnaire was selected as the source of data collection from respondents while the descriptive and inferential statistics were selected to analyse the responses using SPSS V27 software. The University of Technology Ethics Policy was complied with as approvals were also obtained to access the respondents.

Chapter five analysed and discussed findings obtained from the survey that was conducted to investigate the factors that influence hackathon adoption for teaching and learning of CP in HE institutions. The data collected were interpreted and analysed to understand the adoption of hackathon to provide meaningful facts and information. The findings show students have a positive behavioural intention to adopt hackathon for teaching and learning of computer programming.

Chapter six presents summary of the findings, conclusion, and recommendations. The chapter also discusses the contributions of the study to policy, theory, methodology and suggestions for future research.

6.9 Chapter Summary

Overall, the findings suggest that students' cognitive beliefs and awareness will presumably drive them into adopting the technology. Students' contemplating hackathon adoption must find it easy to use as well as perform better in their CP which task plays a critical role throughout the adoption process. The study established that the best predictors of hackathon adoption for teaching and

learning computer programming are performance expectancy, relative advantage, perceived usefulness, and self-efficacy. Although the study found that relative advantage, perceived usefulness, performance expectancy, and self-efficacy facilitate adoption, the results also demonstrate that extra effort, referent opinions of others and lack of support facilities thereof may inhibit implementation of the technology. This suggests that institutions should strive to strengthen internal IT facilities through training and develop IT curricula that makes it easier to learn computer programming with less effort to counteract concerns related to hackathon adoption. Also, much effort should be put in place to create awareness and introduce hackathon earlier in their CP curriculum so that the true benefit of adopting hackathon is implemented and incorporated into their daily programming activities.

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APPENDICES

APPENDIX A1: LETTER OF INFORMATION/COVERING LETTER

Dear Prospective Participant

My name is Oyetade Kayode Emmanuel, a registered PhD student in the department of Information and Communication Technology, at the Vaal University of Technology.

I am conducting a study entitled: **A Framework for the Adoption of Hackathon for teaching and learning of Computer Programming**.

My promoters are Prof Tranos Zuva and Dr Anneke Harmse from the ICT Department, VUT.

You are being invited to take part in a research study. Please take the time to read the following information carefully as contained below.

Background: This questionnaire will assess your perception on the adoption of **Hackathon** for teaching and learning of computer programming in South African higher education institutions. A **Hackathon** is an event in which many student/people meet to engage in collaborative computer programming.

Study Procedure: Your expected time commitment for this study is 5-7 minutes. Indicate your level of agreement or disagreement by ticking the appropriate columns in the questionnaire.

Voluntary Participation: Your participation in this study is voluntary. It is up to you to decide whether to take part in this study. If you do decide to take part in this study, you will be asked to sign a consent form. If you decide to take part in this study, you are still free to withdraw at any time and without giving a reason. You are free to not answer any question or questions if you choose. This will not affect the relationship you have with the researcher.

Risks: The risks of this study are minimal. These risks are like those you experience when disclosing work-related information to others. The topics in the survey may upset some respondents. You may decline to answer any or all questions and you may terminate your involvement at any time if you choose.

Benefits: There will be no direct benefit to you for your participation in this study. However, we hope that the information obtained from this study may assist in using the model to write papers published in journals and conference proceedings to improve quality of computer programming education.

Confidentiality: Please do write any identifying information on your questionnaire. Your responses will be anonymous.

Costs to Subject: There are no costs to you for your participation in this study

Compensation: There is no monetary compensation to you for your participation in this study.

APPENDIX A2: CONSENT TO PARTICIPATE IN THE STUDY

Research Ethics Clearance Number: _____

- I hereby confirm that I have been informed by the researcher, **Oyetade Kayode Emmanuel** about the nature, conduct, benefits, and risks of this study
- I have also received, read, and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had enough opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during this research which may relate to my participation will be made available to me.
- I am aware that the findings of this study will be processed into a research report, Journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I, **Oyetade Kayode Emmanuel** herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

_____ _____

Date **Signature**

Participant Name & Surname……

Participant Signature …….

APPENDIX B: QUESTIONNAIRE

Dear Participant,

All the information given here will be kept confidential. Kindly assist by providing honest and reliable answers to the questions by ticking the box that best describes you.

Thank you for your time and anticipated cooperation.

SECTION A: SOCIO-DEMOGRAPHIC CHARACTERISTICS

A1.	Gender	Male ☐	Female ☐				
A2.	Age	15 - 19	20 – 25	26 - 31	Above 31		
		☐	☐	☐	☐		
A3.	Ethnicity	African	Indian	Coloured	White	Others	
		☐	☐	☐	☐	☐	
A4.	Years of Computer Experience	0-2 ☐	3-5 ☐	6-8 ☐	9-11 ☐	Above 12 ☐	
A5.	Education Level	First Year ☐	Second Year ☐	Third Year ☐	Fourth Year ☐	Masters ☐	PhD ☐

SECTION B: For each of the questions below, kindly indicate your level of agreement or disagreement by ticking the appropriate column.

1. Strongly Disagree 2 - Disagree 3 – Neutral 4 – Agree 5 – Strongly Agree

S/No	**Items**					
	Effort Expectancy: The level of easiness related while using Hackathon to learn Computer Programming.	**1**	**2**	**3**	**4**	**5**
1	Learning how to use Hackathon will be easy for me.					
2	My interaction with Hackathon for Computer Programming task will be clear and understandable.					
3	I will find Hackathon easy to use.					
4	It will be easy for me to become skillful at using Hackathon to learn Computer Programming.					

	Performance Expectancy: the degree to which the user expects that using the Hackathon will help him or her to attain gains computer programming.	**1**	**2**	**3**	**4**	**5**
5	I will find Hackathon useful in learning Computer Programming.					
6	Using the Hackathon will increase my Computer Programming productivity.					
7	Using Hackathon will help/enable me accomplish Computer Programming tasks more quickly.					
8	Using Hackathon will increase my chances of achieving Computer Programming tasks that are important to me.					

	Attitude: Refers to an attitude that one feels positively toward learning CP using Hackathon	**1**	**2**	**3**	**4**	**5**
9	Using the Hackathon to learn computer programming is a good/bad idea.					
10	Using the Hackathon to learn computer programming Hackathon is a wise/foolish idea.					
11	I like/dislike the idea of using the Hackathon to learn computer programming					
12	Using the Hackathon to learn computer programming will be pleasant/unpleasant.					

1. Strongly Disagree 2 - Disagree 3 – Neutral 4 – Agree 5 – Strongly Agree

	Subjective Norm: Individual's perception of social pressure to perform or not to perform the behaviour.	1	2	3	4	5
13	People who influence my behaviour think that I should use Hackathon					
14	People who are important to me think that I should use Hackathon					
15	People whose opinions that I value prefer that I use Hackathon					

1. Strongly Disagree 2 - Disagree 3 – Neutral 4 – Agree 5 – Strongly Agree

	Facilitating Conditions: degree to which an individual believes that organizational and technical infrastructure exists to support use of the system.	1	2	3	4	5
16	Guidance is available to me in using Hackathon to learn computer programming.					
17	Specialized instruction concerning Hackathon was available to me.					
18	A specific person (or group) is available for assistance with difficulties in learning computer programming via Hackathon.					

	Perceived Usefulness: Perceived usefulness is a feeling that one holds toward the improvement in learning CP	1	2	3	4	5
19	Using Hackathon to learn computer programming gives me greater control					
20	Using Hackathon to learn computer programming enables me to accomplish tasks more quickly					
21	Using Hackathon to learn computer programming supports critical aspects of learning.					
22	Using Hackathon to learn computer programming saves me time					
23	Using Hackathon to learn computer programming increases my productivity.					
24	Overall, I find the Hackathon useful in my studies.					

1. Strongly Disagree 2 - Disagree 3 – Neutral 4 – Agree 5 – Strongly Agree

	Perceived Ease of Use: Refers to a level of easiness that one feels when using Hackathon to learn CP.	1	2	3	4	5
25	Learning to operate the Hackathon will be easy for me.					
26	I will find it easy to get Hackathon to do what I want it to do.					
27	My interaction with Hackathon will be clear and understandable.					
28	I will find the Hackathon to be flexible to interact with.					
29	It will be easy for me to become skilful at using the Hackathon to learn Computer Programming.					

	Behavioural Intention: Refers to one's willingness to continue to learn computer programming via Hackathon	1	2	3	4	5
30	I plan to use Hackathon for learning in the future					
31	I intend to continue using Hackathon for learning computer programming in the future					
32	I think Hackathon should be implemented in learning computer programming					
33	I expect my use of Hackathon to continue in the future					

	Self-Efficacy: The belief that one has the capability to perform a behaviour	1	2	3	4	5
34	I could complete my learning activities using Hackathon if there was no one around to tell me what to do					
35	I could complete my learning activities using Hackathon if I could call someone for help if I got stuck					
36	I could complete my learning activities using Hackathon if someone else had helped me get started					
37	I could complete my learning activities using Hackathon if I had a lot of time to complete the task for which Hackathon was provided					
38	I could complete my learning activities using Hackathon if I had instructions only instructions for reference					

1. Strongly Disagree 2 - Disagree 3 – Neutral 4 – Agree 5 – Strongly Agree

	Relative Advantage: Degree to which a new product (Hackathon) is more advantageous to the customers than the competing brands.	1	2	3	4	5
39	Using the Hackathon enables me to accomplish computer programming tasks more quickly.					
40	Using the Hackathon improves the quality of the computer programming work I do.					
41	Using the Hackathon makes it easier to learn.					
42	Using the Hackathon enhances my effectiveness in the class.					
43	Using the Hackathon increases my productivity.					

Thank you for taking the time to complete this survey.

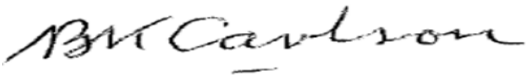
APPENDIX C: LETTER CONFIRMING EDITING

8 Nahoon Valley Place
Nahoon Valley
East London
5241
04 March 2022

TO WHOM IT MAY CONCERN

I hereby confirm that I have proofread and edited the following dissertation using the Windows 'Tracking' system to reflect my comments and suggested corrections for the students to action:

A Framework for the Adoption of Hackathon for Teaching and Learning of Computer Programming by K.E Oyetade, a thesis submitted to the Graduate School of Vaal University of Technology in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Information Technology in the Department of ICT.



Brian Carlson (B.A., M.Ed.)

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Disclaimer: Although I have made comments and suggested corrections, the responsibility for the quality of the final document lies with the **student** in the first instance and not with myself as the editor.