Factors Influencing Hackathon Adoption for Learning Information Technology (IT) Programming Modules

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Abstract – **Hackathon as a social event has been identified as a method that assists participants collaborate and solve technical design challenges in a limited time. With the numerous hackathon potentials, its significance in computer and IT programming courses have not been fully explored for teaching and learning. The hackathon concept has been in existence for some times, and research on the adoption of hackathon has been limited to the industry but not much in education. This paper endeavours to investigate the factors that influence hackathon adoption in the academic sector particularly in higher education. Quantitative research was undertaken; a survey was administered to a sample of 249 South African IT programming students. The results indicate that relative advantage ($\beta = 0.142, \rho = 0.045$), perceived usefulness ($\beta = 0.141, \rho = 0.036$), performance expectancy ($\beta = 0.205, \rho = 0.002$), and self-efficacy ($\beta = 0.330, \rho = 0.000$) have a positive influence on the behavioural intention of students to adopt hackathon for learning IT programming. The hackathon adoption model was developed for higher education. This research helps in the adoption of hackathons in higher education.**

Keywords – **hackathon, higher education, information technology, computer programming.**

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1. Introduction

Hackathon could enhance IT students' problem-solving, interest and creativity as it engages them in the learning process and retention of new information [1], [2]. It is a short time interactive innovation focusing on some use of computer skills and are based on ideas developed in response to a clear problem statement with input from a diverse team and presented to a live audience [3], [4]. Hackathons has since become a regular phenomenon and have been held worldwide in various sectors to solve intricate problems by producing innovative solutions [3], [4].

Adjusting to real-world software development teams is a problem facing IT students since they possess diverse skill sets [5], [6]. Hence, an alternative learning environment that introduces and motivate students to develop good programming skills via constant practice and interaction with their colleagues is important to prepare them for real-world settings [6], [7]. With more organizations and institutions realizing the potential that hackathons can offer, the need for improved theoretical constructs to define effective long-term learning should be identified.

This article provides researchers and stakeholders in this field with new insight into the factors that influence hackathon adoption for learning programming with empirical evidence, allowing them to make the right decisions that add greater value to academic curricula.

2. Literature Background

Technology adoption is often illustrated in a lifecycle model that describes the acceptance of new technology according to a user group's demographics, psychological, and sociological characteristics. Technology adoption theory examines an individual's choices to accept or reject an innovation. In the broadest sense, innovation can be a perception of novelty or an idea, object or practice to a populace and the extent to which that innovation is integrated into the appropriate context [8], [9]. Theories of technology adoption known to describe user adoption include Diffusion of Innovation theory (DOI), Theory of Planned Behavior/Theory of Reasoned Action (TRA/TPB), Technology Acceptance Model, Unified Theory of Acceptance and Use of Technology (UTAUT), and Social Cognitive Theory (SCT) [10], [11]. However, these theories and models have been identified and used to understand change for technology in education. These are discussed in the following section.

2.1. Diffusion of Innovation (DOI)

Introduced by Rogers to explain the adoption rate for various technologies across various channels and stages since an individual have changing degrees of enthusiasm to adopt innovation, and that over time, or depending on which stage in the adoption process the adopter found themselves [8]. DOI introduces four factors from diverse innovations that influence the diffusion of a new idea. This includes time, channel communication, innovation, and the social system. The adoption rate of innovation is faster as more people create and share information with mutual understanding [2], [8].

2.2. Technology Acceptance Model (TAM)

TAM was developed to explain an individual's acceptance and use of technology [12]. Perceived usefulness (PU) and perceived ease of use (PEOU) are two important variables that influence the use of the system by an individual [12], [13]. PU is the confidence an individual has that using a system will improve their performance. PEOU is an individual's belief that using a given application is effortless [12], [14]. The TAM model has evolved over the years through various stages where the BI replaces the attitude once it was found that PU and PEOU directly influence BI [13].

2.3. Social Cognitive Theory (SCT)

Bandura [10] developed the SCT model to understand the relationship between environmental factors and personal behavior. It is a connecting triadic structure of, firstly, personal factors (cognitive, affective, and biological events characterizing a person), secondly, behavioral patterns (performance, usage, and adoption issues), and lastly, environmental events (social and physical factors that are external to the individual). They operate as interacting determinants that influence one another bidirectionally [10], [15]. SCT model evaluates IT use by means of constructs such as self-efficacy (SE), outcome expectations performance, outcome expectations personal anxiety, and affect [11].

2.4. Unified Theory of Acceptance and Use of Technology (UTAUT)

Venkatesh et al. [13] reviewed eight information system models previously used to formulate an all-inclusive newer model called the UTAUT by tailoring fourteen initial constructs. Four consolidated constructs were conceived to be factors of behavioral intention. The important constructs are effort expectancy (EE), performance expectancy (PE), facilitating conditions (FC), and social influence (SI). Also, four important moderating variables gender, experience, age, and voluntariness of use to influence technology adoption were identified [11], [13, [15].

2.5. Theory of Reasoned Action/Theory of Planned Behaviour (TRA/TPB)

TRA and TPB were developed out of a theoretic custom that considered attitudes a major influence on human behavior. TRA theorizes behavior is a function of behavioral intentions (BI). This is also a function of attitudes (individual's positive or negative emotional state) and subjective norms (individual's perception of what close people think about the behavior they should display) [16], [17]. TPB extended the components of TRA by adding perceived behavioral control (PBC) as a determining factor predicting BI and behavior [16], [18], [19]. In TPB, Attitude, Subjective Norm (SN) and PBC constructs are correlated. The three constructs directly impact BI which in turn determines actual behavior. PBC is an individual's perception to act out a given behavior easily [11].

2.6. Summary Comparative Model Analysis

The following constructs in Table 1 were identified by drawing on the review of technology adoption theories above.

3. Research Model and Hypothesis

Notable technology adoption frameworks and models have been used to study and explain the adoption of various technologies. The review of literature revealed a need for a combination of technology adoption frameworks to explain hackathon adoption since one theory or model cannot meaningfully explain the adoption of technologies [9]. By drawing on the technology adoption models, and recent technological literature discussed above, an integrated model of hackathon adoption for learning IT programming is developed. The theoretical framework combines factors from TAM, TPB, TRA, UTAUT, and DOI as likely explanatory factors and guides the development of the hypothesis and the model. The model states that PE, EE, FC, attitude, SN, PU, PEOU, RA, and SE influence BI to adopt hackathons. The following hypothesis in Table 2 was proposed which is translated into the conceptual framework in Figure 1.

Table 1. Constructs derived from reviewed theories

Theory	**Core Constructs**
TAM	PU and PEOU
TRA/TPB	BI, attitude, SN, and PBC
SCT	Outcome expectation, SE, Affect, and Anxiety
DOI	Relative advantage, compatibility, ease of use, image, visibility, compatibility, result demonstrability, the voluntariness of use
UTAUT	PE, EE, SI, FC, BI, age experience, gender, and voluntariness

Table 2. Proposed Research Hypothesis

No	**Proposed Hypothesis**
H_1	Performance expectancy has a positive influence on behavioural intentions to adopt hackathon
H_2	Effort expectancy has a positive influence on behavioural intentions to adopt hackathon
H_3	Facilitating condition has a positive influence on behavioural intentions to adopt hackathon
H_4	Attitude has a positive influence on behavioural intentions to adopt hackathon
H_5	Subjective norm has a positive influence on behavioural intentions to adopt hackathon
H_6	Perceived usefulness has a positive influence on behavioural intentions to adopt hackathon
H_7	Perceived ease of use has a positive influence on behavioural intentions to adopt a hackathon
H_8	Relative advantage has a positive influence on behavioural intentions to adopt hackathon
H_9	Self-efficacy has a positive influence on behavioural intentions to adopt hackathon

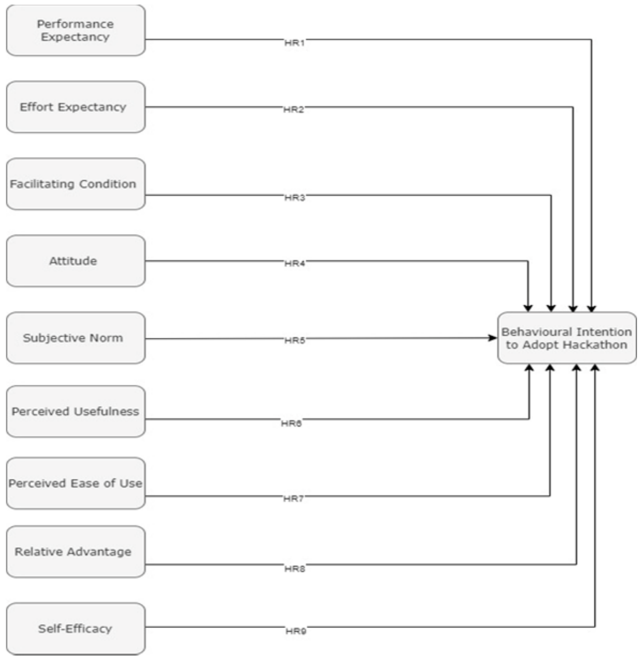

Figure 1. Conceptual framework for hackathon adoption

4. Research Methodology

A deductive approach using the quantitative research strategy was adopted for the study. Inferential statistics was used for data analysis.

4.1. Population, Sample, and Procedure

The survey was administered through an online learning management system targeted at South African University students studying IT programming modules. A link to the online survey was loaded on the landing page of the LMS for the students studying IT programming courses to ensure only registered have access to the questionnaire and was set to disable as soon as they submitted the questionnaire to ensure that no duplicate responses were logged.

4.2. Data Collection

Due to the COVID-19 pandemic, a limitation for a larger sample emerged because of restricted movement. Of the IT programming students targeted as the population, a sample of 249 respondents participated in the survey. The questions within the questionnaire were designed to gain insight into hackathon adoption. To avoid errors during the data collection phase, the final questionnaire and instructions used in this survey were well-drafted to avoid respondent confusion.

4.3. Questionnaire Design

The questionnaire contained 44 self-reported item to examine participants' responses to the nine constructs established to determine factors affecting hackathon adoption by IT programming students [13], [20], [21]. PU was measured using six items. PEOU and RA were measured using five items. EE, PE, ATT, BI, and SE were measured using four items and SN and FC were measured using three items. These constructs were based on a 5-point Likert scale where 1 (strongly disagree) and 5 (strongly agree).

5. Results

The result obtained using SPSS are discussed below.

5.1. Descriptive Statistics

The descriptive statistics in Table 3 presents the demographic characteristics of participants' information. A simple majority of the responses are males between the ages of 20 and 25 of the responses obtained, accounting for 59.4 percent of the responses rate. This shows an unequal response rate between males and females (40.6 percent) as more females need to be encouraged to take IT programming courses. Almost all participants of the survey (99.2 percent) are African. There was almost an even split in the years of experience of those with 0-2 and 3-5 years of experience representing 43% and 41%. About half of the respondents are second-year students while the rest of the responses are spread amongst first, third, and fourth-year students.

5.2. Reliability Test

A reliability test was done to confirm if each factor of the hackathon adoption instrument is reliable and valid. Cronbach's alpha (α) was used to assess the reliability of the scales for each of the constructs in this study. All the constructs in the questionnaire items had a Cronbach value of 0.74 as shown in Table 4. Generally, an alpha value above 0.7 is considered acceptable [22].

5.3. Factor Analysis

Factor analysis was performed, the result showed: KMO and Bartlett's test of sphericity value of 0.933, with a significant ρ-value ($\rho < 0.000$) (Table 5 refers). Eight items (PEOU1-PEOU6, SE1, EE4) were dropped due to low communalities (< 0.5), low factor loadings (< 0.4), and cross-loadings with other factors. We indicate FA, it was confirmed all the remaining items were loaded within their respective construct as shown in Appendix 1. The final FA produced as simple structure of nine factors explaining 68.87% of the cumulative variance. The following section used the final factor structures to carry out the regression analysis.

Table 3. Demographic attributes of respondents' characteristics

Demographic Categories	Frequency	Percent
Gender		
Male	148	59.4%
Female	101	40.6%
Age		
15-19	30	12.0%
20-25	186	74.7%
26-31	28	11.2%
Above 31	5	2.0%
Ethnicity		
African	247	99.2%
Colored	1	0.4%
Others	1	0.4%
Years of Computer Experience		
0-2	107	43.0%
3-5	102	41.0%
6-8	20	8.0%
9-11	10	4.0%
Above 12	10	4.0%
Education Level		
First Year	62	24.9%
Second Year	124	49.8%
Third Year	44	17.7%
Fourth Year	19	7.6%

5.4. Regression Analysis

Nine factors from the study were subjected to linear regression analysis to estimate factors influencing hackathon adoption. Independent variables are SN, EE, FC, ATT, SE, PU, PE, RA, and the dependent variable is BI.

The summary of the standard regression model in Table 6, the $R^2 = 0.59$ suggests that all the independent factors combined contribute 59% of the variances in students' behavioral intention to adopt hackathon. The summary of predictive factors in terms of significance values for each individual factor obtained from regression analysis indicate ATT($\beta = 0.008, \rho = 0.886$); EE ($\beta = 0.088, \rho = 0.112$), FC ($\beta = -0.033, \rho = 0.951$) and SN ($\beta = 0.049, \rho = 0.330$). Since $\rho > 0.05$ then they are not statistically significant. This implies that students' BI to adopt hackathon is not influenced by attitude, facilitating condition, social norm, and effort expectancy. Moreover, PU ($\beta = 0.141, \rho = 0.036$), RA ($\beta = 0.142, \rho = 0.045$), PE ($\beta = 0.205, \rho = 0.002$) and SE ($\beta = 0.330, \rho = 0.000$). Since $\rho < 0.05$, then they are statistically significant.

Table 4. Reliability Values

Construct	Cronbach's values
Effort Expectancy	0,859
Performance Expectancy	0,925
Attitude	0,838
Social Norm	0,832
Facilitating Condition	0,835
Perceived Usefulness	0,909
Perceived Ease of Use	0,748
Behavioural Intention	0,916
Self-Efficacy	0,968
Relative Advantage	0,926

Table 5. 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

Table 6. Model Summary

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
1	.768[a]	0,59	0,576	0,48601

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

This indicates PU, RA, PE, and SE positively influence students' adoption of a hackathon. This supports previous research that these factors are a strong determinant of intention to adopt technologies using the different technology adoption frameworks [13], [23], [24].

6. Data Analysis and Discussion

The result of the descriptive statistics in Table 3 shows that the gender of students seems to be skewed towards males however, there seems to be a balance between the male and female students overall. This could be because male students tend to take more interest in IT courses. Also, the age of students who participated in the survey tend to skew towards are between the ages of 20 – 25. This seems to be the average of students entering higher education institutions in South Africa. The empirical testing of the conceptual hackathon model proposed has resulted in the final hackathon adoption model presented in Figure 2. The inferential test indicated the hypotheses that were rejected and accepted. This is presented in Table 7.

Table 7. Regression test results

H_{No}	Proposed Hypothesis	Result
H_1	Performance expectancy has a positive influence on behavioural intentions to adopt hackathon	Accepted
H_2	Effort expectancy has a positive influence on behavioural intentions to adopt hackathon	Rejected
H_3	Facilitating condition has a positive influence on behavioural intentions to adopt hackathon	Rejected
H_4	Attitude has a positive influence on behavioural intentions to adopt hackathon	Rejected
H_5	Subjective norm has a positive influence on behavioural intentions to adopt hackathon	Rejected
H_6	Perceived usefulness has a positive influence on behavioural intentions to adopt hackathon	Accepted
H_7	Perceived ease of use has a positive influence on behavioural intentions to adopt hackathon	Rejected
H_8	Relative advantage has a positive influence on behavioural intentions to adopt hackathon	Accepted
H_9	Self-efficacy has a positive influence on behavioural intentions to adopt hackathon	Accepted

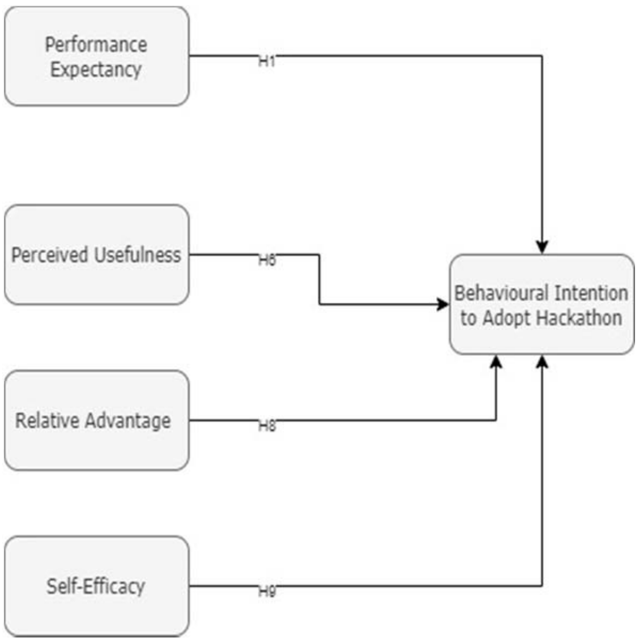

Figure 2. Final hackathon adoption model

7. Conclusion

The study proposed to determine the factors that influence the adoption of a hackathon for learning IT programming and found that PE, PU, RA, and SE influence BI to adopt hackathons. Although EE, FC, ATT, SN was found to be significant in other studies, this study found them not to influence BI to adopt hackathon. The study recommends that when people adopt hackathons, the PE, PU, RA, and SE of the intended beneficiaries have to be measured. Future research will need to investigate why the factors were not significant within the hackathon domain in academic settings when they are accepted in different environments.

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Appendix 1: Hackathon Factor Analysis Loading

	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								
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			
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