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UTAUT ANALYSIS OF THE CONTRACTOR'S PERCEPTION OF THE MACHINERY MOBILE APPLICATION IN THE NORTHERN REGION OF PENINSULAR MALAYSIA

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Abstract:

The construction industry in the Northern Region of Peninsular Malaysia, especially contractors faces common challenges in project construction delivery such as cost overruns and delays due to a lack of understanding and implementation of digitalization to coordinate construction activities. To overcome these issues, a study on the "acceptance" level related to the digitalization of procurement and logistics in construction deliverables through mobile applications is essential to identify the contractor's understanding and practices in utilizing a digital tool known as Machinery Mobile Application (MMA). This study aims to identify the factors affecting the "acceptance" of MMA through material ordering activities for construction projects among Malaysian contractors. Therefore, this study utilizes a quantitative approach via online surveys focusing on 86 selected professional contractors with CIDB registered as Grade 6 and Grade 7 in the Northern states of Malaysia and continues to analyze the collected data by using Relative Importance Index (RII) analysis. The results showed that the highest acceptance factor identified is SE3-collaboration among stakeholders in implementing MMA, while the lowest acceptance factor is EE5-external coaching in operating MMA. The study is in line with the upcoming National Construction Plan 2030 through

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"Thrust 1 – Technology as Game Changer" which benefits the Malaysian Government, CIDB, and local construction firms.

Keywords:

Acceptance; Machinery Mobile Application; Construction; Contractors; Relative Importance Index.

Introduction

The construction sector faces challenges in implementing machinery mobile applications due to limited awareness, compatibility issues, and user learning curves (Usman et. al., 2020). Moreover, the construction industry faces challenges such as delays, rework, and cost overruns due to inefficient material ordering and poor coordination. The slow adoption of machinery mobile applications exacerbates these challenges, leading to productivity issues and project delays (Lu et al., 2020). With mobile applications for machinery management promising to increase efficiency and transparency, the construction sector is embracing smart construction (Zhinhe, 2018). However, because of problems with knowledge transfer, user-friendly interfaces, and the absence of industry standards, adoption is sluggish (Heigermoser et al., 2019). The absence of standardized formats hinders seamless data exchange and collaboration, necessitating comprehensive research to assess market acceptance (Hossain et al., 2019).

This study was carried out to evaluate the market acceptability of mobile applications for machinery in construction sites in the Northern Region of Peninsular Malaysia. The study aims to discover current material ordering practices, determine factors influencing the acceptance of machinery mobile applications, and assess contractors' acceptance levels in Malaysia's Northern region. Ultimately, this study bridges the gap for enhancing usability and effectiveness in the construction sector. The research contributes to harmonizing the digital construction culture in obedient with the National Construction Plan 2030 focusing on "Thrust 1 – Technology as Game Changer". Furthermore, this study has significant implications for governmental, theoretical, and societal groups of beneficiaries of digital construction in Malaysia.

Literature Review

The review explores the current adoption of machinery mobile application technology at construction sites, focusing on the contractors' experiences and factors of market acceptance. It also examined the relationship between technology and business operations and the Unified Theory of Acceptance on Technology (UTAUT).

Review of the Technology Adaptation at the Construction Sites

The adaptation of technology at construction sites involves integrating tools like mobile applications, websites, and other digital platforms to enhance efficiency, safety, and productivity (Rakshit et al., 2021). Mobile applications, designed for tasks like equipment monitoring, real-time reporting, and stakeholder communication, play a pivotal role in this transition. Traditionally, construction sites relied on manual processes due to their dynamic nature, lack of infrastructure, and resistance to change. However, Industrial Revolution 4.0 (IR4.0) in engineering has stimulated the application of digital technologies to enhance the engineering quality, safety, and productivity of the construction industry through BIM, big data, blockchain, 3D printing, augmented reality, photogrammetry, laser scanning, GIS, GPS,

Volume 6 Issue 19 (December 2024) PP. 115-126
DOI 10.35631/IJIREV.619009

AI, and robotics at construction sites. (Mudan, 2020). Developing countries require a well-functioning public integrated modeling system for optimal construction progress (Agaba and Shipman, 2007).

In Malaysia, technology adoption has been promoted nationwide, with CIDB Malaysia focusing on BIM in their 3rd strategic thrust. Contractors' experience with iBIM is measured by resistance, lack of training, consultants, leadership, and specialist staff (Badr et al., 2020). Traditional construction methods, such as manual tendering, lead to corruption and time wastage (Usman et al., 2020). The adoption of machinery apps in the Northern region of Peninsular Malaysia aims to improve transparency, productivity, cost savings, and integrity, and reduce corruption in procurement processes.

Studies have shown that Machinery app software, such as BIM, is beneficial in the construction industry for on-site assembly services and improving logistics performance (Li et al., 2018). However, Park (2020) stated that factors such as acceptance type, educational satisfaction, usage enjoyment, and experience impact perceived usefulness and ease of use. This study aims to evaluate the acceptance of Machinery app software in Malaysian construction, focusing on procedural and easy education to ensure its effective adoption.

Digitalization Effect towards Business Operation

Park (2020) emphasizes the importance of digitalization in real-world applications, with factors such as acceptance type, educational satisfaction, and usage enjoyment impacting perceived usefulness. Ruwini (2019) supports this, citing the exponential growth of smart technologies in construction. Digital data can help project teams formulate strategies for big data operations (Yu et al., 2020).

Model Adopted Unified Theory of Acceptance on the Use of Technology (UTAUT)

This research employs two independent variables from previous studies, based on the Unified Theory of Acceptance on the Use of Technology (UTAUT) adapted from Ma (2023), and dependent variables related to contractor acceptance of the Machinery application as shown in Figure 1.

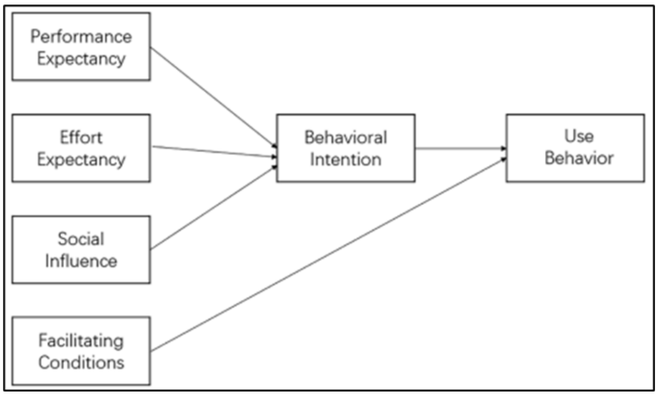

Figure 1: Unified Theory of Acceptance on the Use of Technology (UTAUT) Factors
Source: Adapted from Ma (2023)

In Figure 1, the UTAUT model identifies three main independent variables: performance expectancy, effort expectancy, and social influences, which are directly linked to behavioral intentions. The final factor, facilitating conditions, is associated with definite usage. According

International Journal of Innovation and Industrial Revolution
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IJIREV
Volume 6 Issue 19 (December 2024) PP. 115-126
DOI 10.35631/IJIREV.619009
to Ma (2023), Performance Expectancy (PE) refers to an individual's belief that using a system will improve job performance, while Social Expectancy (SE) refers to the belief that others believe the system should be used, Effort Expectancy (EE) refers to “the degree of ease associated with the use of the system” and Facilitating Conditions (FC) refers to “the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system”. The independent variable considered as the main factor and sub-factor of market acceptance regarding UTAUT is shown in Table 1.

Table 1: Independent Variable (Factor) and Sub-Factor of UTAUT

Factor	Sub-Factor
Performance Expectancy (PE)	Perceived Usefulness
	Extrinsic Motivation
	Job-Fit
	Relative Advantage / Competency
	Outcome Expectations
	Business Performance
Effort Expectancy (EE)	Ease of Use
	Simplicity
	Willingness to adapt to new technology
	Attempting to grow business operation
	Training
	Learning Curve
Social Expectancy (SE)	Internal support
	External support
	Collaboration
	Perception
Facilitating Condition (FC)	Availability of infrastructure
	Availability of Time
	Availability of Fund
	Business Operation

Source: Adopted From Ma (2023)

This study nominates the dependent variable in the spectrum of customer acceptance, specifically for contractors. Danilo (2016) emphasizes customer acceptance as the most crucial factor in commercially successful innovation, alongside technological feasibility, entrepreneurship, and customer need/want (Paul, 1992). This study aims to assess customer acceptance of Malaysian contractors in the northern region, focusing on grade 6 or 7 registered with CIDB Malaysia, affecting their business operations.

Methodology

The research was conducted in Malaysia focusing on four northern states which are Perlis, Kedah, Pulau Pinang, and Perak. After a desk study on the research gap has been identified through a Systematic Literature Review (SLR), there are 20 factors of acceptance were discovered through the Unified Theory of Acceptance on the Use of Technology (UTAUT) as shown in Table 2.

International Journal of Innovation and Industrial Revolution IJIREV
EISSN: 2637-0972
Volume 6 Issue 19 (December 2024) PP. 115-126
DOI 10.35631/IJIREV.619009

Table 2: Factor Of Acceptance Adapted From UTAUT

Factor	Sub-Factor	Code
Performance Expectancy (PE)	Perceived Usefulness	PE1
	Extrinsic Motivation	PE2
	Job-Fit	PE3
	Relative Advantage / Competency	PE4
	Outcome Expectations	PE5
	Business Performance	PE6
Effort Expectancy (EE)	Ease of Use	EE1
	Simplicity	EE2
	Willingness to adapt to new technology	EE3
	Attempting to grow business operation	EE4
	Training	EE5
	Learning Curve	EE6
Social Expectancy (SE)	Internal support	SE1
	External support	SE2
	Collaboration	SE3
	Perception	SE4
Facilitating Condition (FC)	Availability of infrastructure	FC1
	Availability of Time	FC2
	Availability of Fund	FC3
	Business Operation	FC4

Source: Adopted from Ma (2023)

The research continues by utilizing the semi-quantitative data collection method where a questionnaire survey was developed for quantitative data collection activities. The questionnaire survey comprises five sections namely: 1) demographic information; 2) performance expectancy; 3) effort expectancy; 4) social expectancy; and 5) facilitating condition. Section 1 contains questions regarding job position, year of experience, grade of the company as accredited by CIBD, and location of the project, while Section 2 until Section 5 consists of questions with Likert Scale for each factor allowing respondents to answer within a range of 1-5, ranging from very disagree to very agree as shown in Table 3.

Table 3: Likert Scale

Scale	Description
1	Very Disagree
2	Disagree
3	Slightly Agree
4	Agree
5	Very Agree

There were 86 selected panellists involved in this research. Panellists were from various contractor's companies registered with CIDB with G6 and G7 grade and shall be involved with ongoing construction projects, as the study utilizing non-probability sampling and convenience techniques from Krejcie and Morgan (Krejcie et al., 1996). All credentials were selected according to the Point System for Qualification of Expert Panellists adapted from Hallowell and Gambatese (2010) as shown in Table 4.

International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972
Volume 6 Issue 19 (December 2024) PP. 115-126
DOI 10.35631/IJIREV.619009

Table 4: Point System for Qualification of Expert Panelists

ID	Achievement or Experience
A	Years of professional experience in the construction industry: (1 point for every year)
B	Advanced degree in the field of civil engineering or other related areas: (Bachelor’s degree: 1 point, Master's: 2 points, PhD: 4 points)
C	Involved in any related digital data project construction: (2 points for each related software used for project construction)
D	Member (or chair) of professional committee(s): (Member: 1 point for each membership; Chair: 3 points for each membership)
E	Leading position(s) held on current/previous organization related to digital data: (3 points for each leading position)
F	Publication on the topic of digital data in construction (Journal article: 4 points; book: 2 points; conference paper: 1 point)
G	Attended any related digital data training: (1 point for each related data training)
E	Leading position(s) held on current/previous organization related to digital data: (3 points for each leading position)
F	Publication on the topic of digital data in construction (Journal article: 4 points; book: 2 points; conference paper: 1 point)
G	Attended any related digital data training: (1 point for each related data training)

Source: Adapted from Hallowell and Gambatese (2010)

To ensure the factors of acceptance can be measured in quantifiable figures, the research utilized quantitative data analysis to analyze reliability and acceptance levels by using Relative Importance Index (RII) analysis. RII values between 0.8 and 1.0 indicated "High" importance, indicating the significant influence on the acceptance of variables (Chougule et al. 2020). The acceptance level was directly associated with RII values, indicating a significant impact on the research context (Tholibon et al. 2021). This index value aids in ranking each factor based on its degree of importance. The formula for the Relative Importance Index (RII) is expressed in Equation 1.

Equation 1: Relative Importance Index (RII)

$$RII = \frac{\sum w}{AN} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N}$$

The qualitative analysis of the study was conducted where the author validated data from a quantitative study by verifying the rating of the RII results with experts in construction through content analysis. Qualified experts were also chosen using a point system proposed by Hallowell and Gambatese (2010).

International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972
Volume 6 Issue 19 (December 2024) PP. 115-126
DOI 10.35631/IJIREV.619009

Result and Discussion

Data Reliability

The study aimed to assess the reliability of a research study by selecting CIDB-registered G6 and G7 construction companies in Malaysia with ongoing digital construction projects, using non-probability sampling and analyzing job position distribution as shown in Table 5.

Table 5: Job Position and Number of Respondents

Job Position	Number of Respondent (N)	Percentage (%)
Company Director	21	21
Project Manager	41	41
Supervisor	13	13
Engineer	25	25
Total	100	100

From Table 5, the study reveals that the majority of respondents are experienced manpower, with 21% company directors, 41% project managers, and 13% supervisors for ongoing construction projects at Northen Malaysia, and 25% from positions of engineers.

In the spectrum of respondent experience, the study reveals that 26% of respondents have 0-5 years of experience, 22% have 6-10 years, 32% have 11-15 years, and 20% have over 20 years in the Malaysian construction industry as shown in Table 6.

Table 6: Years of Experience and Percentage

Years of Experience	Number of Respondent (N)	Percentage (%)
0 - 5 Years	26	26
6 - 10 Years	22	22
11 - 15 Years	32	32
More than 15 Years	20	20

The reliability of the study continues with the percentage of construction company grades from the Construction Industry Development Board (CIDB) as shown in Table 7.

Table 7: Percentage of Construction Company Grade From (CIDB)

Grade	Tender capacity (RM)	Paid-up Capital (RM)
G1	200,000 and below	5,000
G2	Up to 500,000	25,000
G3	Up to 1,000,000	50,000
G4	Up to 3,000,000	150,000
G5	Up to 5,000,000	250,000
G6	Up to 10,000,000	500,000
G7	No limit	750,000

Source: CIDB Malaysia

The CIDB Construction 4.0 Strategic Plan (2021-2025) mandates digital construction for G6 and G7 projects, focusing on BIM, IR 4.0, and 2D and 3D modelling. Thus, this research focuses on G6 and G7 construction companies and the percentage distribution is shown in Table 8.

International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972
Volume 6 Issue 19 (December 2024) PP. 115-126
DOI 10.35631/IJIREV.619009

Table 8: Percentage of Respondent based on Grade

Grade	Number of Respondent (N)	Percentage (%)
6	23	27
7	63	73
Total	86	100

Based on Table 8, 27% of G6 companies and 73% of G7 companies, have projects ranging up to 10 million (MYR) and no limit price respectively, suggesting the implementation of digital construction tools. The analysis continues with the understanding of project location distribution at Northen Malaysia States as shown in Table 9.

Table 9: Project Distribution in the Northern States in Malaysia

State	Number of Respondent (N)	Percentage (%)
Perlis	5	5
Kedah	24	24
Pulau Pinang	55	55
Perak	16	16

Table 9 shows that 5% of respondents have construction projects in Perlis, 24% in Kedah, and 55% and 16% in Pulau Pinang and Perak, respectively.

Ranking of UTAUT Factors

The researcher used the Relative Importance Index (RII) to rank factors in UTAUT categories, determining the highest and lowest RII values for prioritization. This helps justify the concentration of interest based on the listed factors as following Table 10.

Table 10: RII Result Ranking for Performance Expectancy (PE) Factors

UTAUT	Factor	Code	RII	Ranking
Performance Expectancy (PE)	Job-fit	PE3	0.898	1
	Relative Advantage	PE4	0.89	2
	Perceive Usefulness	PE1	0.866	3
	Extrinsic motivation	PE2	0.864	4
	Outcomes Expectations	PE5	0.862	5
	Business Performance	PE6	0.814	6

The RII result ranking for Performance Expectancy (PE) factors was prioritized based on the highest to lowest RII value by using a prioritization process. In the highest ranking PE category, PE3-Jobfit gained the highest ranking with a 0.898 RII value. The second ranking was set upon PE4-Relative advantages with a 0.89 RII value. The third ranking for the PE category is PE1-Perceive Usefulness with an RII value of 0.866. The prioritization process detected the fourth ranking from the PE category with a 0.864 RII value which is PE2-Extrinsic Motivation. Next, PE5-Outcomes Expectations placed in fifth ranking with 0.862 RII value. The last ranking of this process is PE6-Business Performance with an RII value of 0.862.

International Journal of Innovation and Industrial Revolution
IJIREV
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Table 11: RII Result Ranking for Effort Expectancy (EE) Factors

UTAUT	Factor	Code	RII	Ranking
Effort Expectancy (EE)	Simplicity	EE2	0.864	1*
	Attempting to grow business	EE4	0.864	1*
	Ease of Use	EE1	0.862	2
	Willingness to adapt to new technology	EE3	0.85	3
	Learning Curve	EE6	0.772	4
	External Coaching	EE5	0.662	5

Table 11 shows the RII ranking for the next category which is Effort Expectancy (EE) factors. With an RII value of 0.864, the top ranking is shared by two EE factors which are EE2-Simplicity and EE4-Attempting to Grow Business. The ranking continues with the second highest ranking in the prioritization process for EE category which is EE1-Ease of Use with 0.862 RII value. The highest third ranking is subjected to the EE3 factor with an RII value of 0.85. EE6-Learning Curve holds the fifth ranking in the EE category with 0.772 and EE5-External Coaching placed as the lowest ranking.

Table 12: RII Result Ranking for Social Expectancy (SE) Factors

UTAUT	Factor	Code	RII	Ranking
Social Expectancy (SE)	Collaboration	SE3	1	1
	Perception	SE4	0.904	2
	External Support	SE2	0.85	3
	Internal Support	SE1	0.846	4

For Social Expectancy (SE), Table 12 shows the highest factor ranking for the SE category in UTAUT which is SE-3 Collaboration with an RII value of 1.00. The second highest ranking in the same category is SE4-Perception with a 0.904 RII value. The last two categories are SE2-External Support and SE1-Internal Support with 0.85 and 0.846 RII values respectively.

Table 13: RII Result Ranking Facilitating Condition (FC) Factors

UTAUT	Factor	Code	RII	Ranking
Facilitating Condition (FC)	Business Operation	FC4	0.858	1
	Availability of Fund	FC3	0.824	2
	Availability of Infrastructure	FC1	0.822	3*
	Availability of Time	FC2	0.822	3*

Table 13 indicates the RII result ranking for FC factors based on RII analysis and prioritization process. The highest ranking is FC4-Business Operation with a 0.858 RII value, followed by FC3-Availability of Fund with an RII value of 0.824. Next, FC1-Availability of Infrastructure and FC2-Availability of Time shared the lowest ranking in the FC category with an RII value of 0.822.

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Validation

The researcher validated data from a quantitative analysis by confirming the ranking of RII from construction experts. Qualified experts were selected using a point system suggested by Hallowell and Gambatese (2010), with three chosen practitioners shown in Table 14.

Table 14: Construction Industry Practitioners for Validation Process

No	Name	Grade	Years	Job Position
1	Respondent 01 (Bachelor of Civil Engineering)	7	12	Project Manager
2	Respondent 02 (Bachelor of Civil Engineering)	7	26	Project Manager
3	Respondent 03 (Bachelor of Civil Engineering)	6	10	Project Manager

Table 14 shows three industry engineers, a 12-point score, and 12 years of industry experience, accumulating 13 points. Respondent 02 has 26 points and a 1-point score, and Respondent 03 has 10 points and 11 points, meeting and slightly exceeding the minimum requirement for validation.

The findings from quantitative questionnaire data justified by grade 6 and 7 project manager interviews. The Relative Importance Index (RII) analysis of UTAUT factors revealed key priorities as identified by industry practitioners. In the Performance Expectancy category, Job-fit (PE3) emerged as the top priority with an RII value of 0.898. For Effort Expectancy, Simplicity (EE2) and attempting to grow business (EE4) jointly claimed the number 1 priority, both securing an RII value of 0.864. Social Expectancy highlighted Collaboration (SE3) as the top priority with an RII value of 1.00, while in Facilitating Condition, Business Operation (FC4) led with an RII value of 0.858. These findings underscore the significance of addressing Job-fit, Simplicity, and Attempting to grow business collectively, Collaboration, and Business Operation in the context of UTAUT, aligning with industry perspectives on factors critical for successful technology adoption and organizational change.

Conclusion and Recommendation

The study analyzed material ordering and purchasing practices in Peninsular Malaysia's Northern region using a literature review and direct contractor interviews. The research provided a comprehensive understanding of the challenges faced by contractors in executing material ordering procedures, ensuring a well-balanced assessment of existing methods. A questionnaire-based survey was conducted to assess the factors influencing contractors' acceptance of machinery mobile applications at construction sites in Peninsular Malaysia. The Unified Theory of Acceptance and Use of Technology (UTAUT) was used to analyze and categorize these factors. The survey involved 86 participants and was analyzed using the Relative Importance Index (RII) to assess the acceptance index value for each factor. The researcher used Relative Importance Index (RII) calculation and prioritization arrangement based on RII value to analyze factors in the Malaysian contractor industry. The study aimed to identify the highest and lowest RII ranks for each factor, and prioritize them based on PE, EE, SE, and FC elements. This research contributes to strategic planning, government policies through CIDB on the consideration to adopt regulations on machinery apps, and academic research on Malaysia's West, East, and South regions.

Future studies should expand geographically to better understand the factors influencing the acceptance of Machinery mobile applications in Malaysia's northern states, the West, East, and South, to ensure a comprehensive understanding of the diverse perspectives and variations across different geographical areas. The recommendation is to adopt a multifaceted approach, considering diverse industry representation and examining the acceptance and utilization of Machinery mobile applications from various stakeholders in the construction industry. Longitudinal analysis is also recommended to track changes over time, providing valuable insights for academia and industry stakeholders. Comparative studies suggest comparing Machinery mobile applications with other technological solutions in the construction industry to gain insights into its advantages and challenges, guiding strategic decision-making for practitioners and policymakers.

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