INTENTION TO USE AUGMENTED REALITY APPS FOR EDUCATION – A BEHAVIOURAL STUDY AMONG MALAYSIAN GENERATION Z

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DECLARATION

We hereby declare that:

(1) This undergraduate FYP is the end result of our own work and that due acknowledgement has been given in the references to ALL sources of information be they printed, electronic, or personal.

(2) No portion of this FYP has been submitted in support of any application for any other degree or qualification of this or any other university, or other institutes of learning.

(3) Equal contribution has been made by each group member in completing the FYP.

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Thank you.

DEDICATION

This research project is exclusively dedicated to my supervisor, Dr. Chong Yee Lee as well as my friends and family members. Thank you for the supporting, encouragement and opinions that being given to me so that I can complete this research on time.

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LIST OF ABBREVIATIONS

AR	Augmented Reality
AW	Awareness
CB	Compatibility
CL	Complexity
DOI	Diffusion of Innovation
DV	Dependent Variable
ICT	information and communication technologies
INT	Intention to use Augmented Reality
IV	Independent Variable
OB	Observability
PDPS	Personal Data Protection Statement
PV	Perceived Value
RA	Relative Advantages
SPSS	Statistical Package for Social Science
TB	Trialability
URL	Uniform Resource Locator
UTAR	University Tunku Abdul Rahman
VIF	Variance Inflation Factor
VR	Virtual Reality

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PREFACE

This final year research project is conducted to fulfil the requirement to complete Bachelor of Marketing (Honours). This project is completed and furnished by the authors based on other conducted research which were quoted as references. We provide all the necessary background on the topic through an exhaustive literature survey.

The title of this research project is “Intention to use Augmented Reality Apps for education - A Behavioural study among Malaysian Generation”. There are a few similar past studies conducted in Malaysia. However, most of them are focus on the virtual reality. Thus, we were driven to carry out this research. This study will give a better insight to generation Z towards Malaysian user to use Augmented Reality in Malaysia.

ABSTRACT

Augmented reality (AR) apps have great potential in education. Compared to traditional education delivery methods, AR apps design and create interactive and immersive experiences that help learners to explore complex concepts in a more tangible way, making learning more accessible, engaging, and enthusiastic. Therefore, the usage of AR enables Gen-Z learners to become more engaged in learning. As AR is a relatively new educational technology system in developing countries like Malaysia, this study aims to investigate Gen-Z's reaction toward the use of AR educational apps.

In determining the target's intentional usage behavior, problems that can possibly explain Gen-Z's reluctance in using AR educational apps were explored. The following behavioral variables were identified: relative advantage, compatibility, complexity, trialability, observability, perceived value, and awareness. In solving the problems, the current research model is developed by enriching the Diffusion of Innovation (DOI) model with two additional variables: perceived value and awareness.

In order to ensure the collected data in the main study can meet the reliability and validity of statistical threshold scores, the questionnaire item statements were robustly examined through pre-test and pilot studies. The item statements were amended according to the pre-test expert and pilot study participant's feedback. The finalized questionnaire item statements that are measured by a 5-point Likert Scale were distributed to 385 Gen-Z respondents using the snowball sampling method.

The main study results show that all hypotheses except the ones related to relative advantage, compatibility, complexity, and observability are related to Gen-Z's usage intention significantly. Suitable recommendations to policymakers, academics, and future researchers are proposed based on the interpretation of hypothesis confirmation results. The project's limitations are also acknowledged, and recommendations are proposed in an attempt to minimize the study limitations and re-occurrence of non-supported hypotheses results.

CHAPTER 1 INTRODUCTION

1.1 Research Background

Augmented reality (AR) is a technological system that creates a digital world that blends an AR user's perception of the real world with holographic objects like text, graphics, images, sound, and other virtual modalities that are captured using the camera on a smartphone or are computer-generated objects (see figure 1.1). In this way, AR users can view the display of data (using virtual reality, VR device) and be able to integrate with sensations like in a real environment. Business companies like IKEA developed an AR system that allows AR shopper users to scan outlet-sold items using their smartphone camera and then place the items into their homes so that shoppers can visualize the scanned items in their home settings.

Figure 1.1: A Sample of Augmented Reality Creation

Source: https://dynamics.microsoft.com/en-us/mixed-reality/guides/what-is-augmented-reality-ar/

AR has been used for medicine, design, entertainment, tourism, and games network. In education, medical and healthcare experts like surgeons, skilled specialists, and students use AR for surgical training in which trainers and trainees can perform complex practical experiments without using expensive resources or risking patient comfort (Suresh, Abdulatif, Stuart, Kamran, & Pokar, 2022). In

surgical education, AR is feasible and effective and able to serve as an additional tool to conventional practical training (Suresh, Abdulatif, Stuart, Kamran, & Pokar, 2022). The virtual experiential learning method is a beneficial educational delivery method that aims to equip learners in applying their theoretical understanding or knowledge to practical endeavors in a variety of contexts without using real objects and/or in a real environment.

AR creates multiple *learning and learning* opportunities across multidisciplinary *contexts (Yan, Colleni, Litts, 2020).* For example, AR helps teachers to learn new teaching skills and educate students about intangible or immaterial or intellectual concepts like understanding the current and future geological stage of a place *(Yan, Colleni, Litts, 2020).* With AR, virtual interaction and experimentation enhance classroom experiences which inspire students to become proactive in exploring new academic interests.

The exponential growth of information and communication technologies (ICTs) and internet access creates an enormous impact on educational delivery practices in the developed and developing countries (Bozkurt, 2020; Camp, 2018; Perron et al., 2010; Shoraevna, 2021). Also, the happening of unprecedented crisis; the spreading of coronavirus in worldwide countries forces educators to develop collaborative team teaching and learning strategies using ICT tools so that students located in any area, especially in remote areas can continue their education learning (Shoraevna, 2021). Despite the changes and beneficial outcomes created by AR in motivating students to participate and committed to the object of study, and teamwork (Algarra, 2020), the usage of the such an application system in multidisciplinary educational settings, especially in social science settings has not been proceeding well in the current 2020s years (Toledo-Moreales and Sanchez-Garcia, 2018).

The Malaysian government is developing a technology-based education delivery system continuously so that learners especially the younger generations like Gen-Z can continue their learning behavior and progress proactively during schooling days and adopt lifelong learning behavior (Gudanescu, 2010). Proactive and productive manpower ensures a country progresses wealthily and healthily in

economic and social sectors. AR technology is gradually being adopted in other industries like logistics and healthcare. In Malaysia, the retail industry has used AR technology. Many foreign subsidiary firms in Malaysian use AR technology as a marketing and entertainment tool (Alam, 2021). Although data indicates that Malaysians are sluggish to accept new technologies, the advantages of using AR technology and its importance in multidisciplinary educational settings cannot be denied. This project targets Gen-Z born between 1995 and 2012 because they are tech-savvy, large population count, have an active social life, and are willing to learn new technology (Salleh, 2017) like AR.

1.2 The Problem Statements

The governments have initiated efforts in recent years with the goal of improving the quality and efficacy of the teaching and learning process. These initiatives are driven by the realization that the traditional chalk-and-speak teaching style, as well as the usage of static textbooks, fail to motivate pupils in increasing their study interest (Astuti et al., 2019). It is believed that through the use of AR apps, students are motivated to explore the study subject further compared to conventional educational delivery methods. However, the usage of AR Apps for education among Gen-Z in Malaysia is still low.

In this topic, potential problems that have been affecting the low implementation and intention to use AR among gen-Z in Malaysia are explored. High cost is always the barrier to implementing AR in education. To Vásquez-Carbonell's (2022) study result, virtual reality and AR are used as innovative tools in mechanical engineering education but the implementation of AR apps is costly (Venkatesan et al. 2021). Nevertheless, AR provides beneficial relative advantages compared to traditional and modern education. The fact is AR app usage is cost-effective in the long run because it provides students the opportunity to experience something that is more costly to be prepared like technical and surgical tools and experiences. Also, AR incorporates a feedback system for student-teacher engagement. The low usage of AR therefore could be driven by the fact that not many potential users (teachers and/or learners) are aware of the relative advantages

that AR can create. To confirm this plausible problem, the authors examined the direct effect of AR's relative advantages on gen-z's usage intentional behavior in the main study.

Interestingly, respondents in past studies were reluctant to use AR apps due to compatibility issues (Louho et al., 2006). Despite the study's respondents being aware of the AR's beneficial usage outcomes, social acceptance of new technologies is still a challenge. Past studies respondents were concerned about the compatibility issue when AR is incorporated into their living lifestyle. They questioned whether the use of AR apps can complement the current educational delivery methods and are compatible with their current learning and living lifestyle. For example, they are worried about their own safety, privacy, ethics, and experience when using wearable technology such as smart glasses and AR-enabled bionic contact lenses in learning contexts (Berryman, 2012). Although the studies are dated some time ago, the usage of AR education apps is still not at an encouraging stage now. This drives the current authors to examine the viability of the compatibility effect in motivating Gen-Z's intention to use AR.

Many potential gen-Z users hesitant to use AR because of they perceive AR is a complex technological system because they assume that they need to utilize several senses and maneuver specific instruments in using AR apps and this challenge those who lack technological talents (Oke & Arowoiya, 2021). Similarly, some studies results show that student respondents decided to disregard instructions or critical phases of the experience because much effort and attention need to be devoted in using the examined AR application (Halasa et al., 2020; Radu, 2012). The respondents were frustrated when they were required to perform a task that is beyond their capability through the use of new technology. In brief, students who are inexperienced with new technology applications found that AR is difficult to be used. Although Gen-Z is categorized as techno-savvy as they are born in the technology revolution era, AR is a new technology system that has not been experienced by many Gen-Z. It is then necessary to find out whether the complexity of AR is a determinant in influencing the gen-z's AR usage intention in this study.

Despite technological advances, most pupils are still accustomed to conventional teaching and learning techniques (Shirazi and Behzadan 2015). Therefore, incorporating new technology such as AR in delivering specific teaching and learning context may be problematic. Another contributing factor is AR is a costly investment learning tool (Ismail, 2017). In order to alert potential users of the beneficial outcomes of using AR apps and it's worthwhile for them to invest in using the technology; AR suppliers need to give the AR trial opportunity to potential users. This study, therefore, examined the effect created by the trialability variable on gen-z's usage intentional.

Although modern technology such as AR has been employed in some non-education industries, the success of using AR depends much on the learner's ability to observe the outcomes or consequences clearly upon using AR education apps. In an investigation of 9th-grade biology students, Erbas and Demirer (2019) discovered that AR learners' academic performance is improving over time because they can clearly sense AR's beneficial outcomes. In brief, in encouraging the gen-z to use AR, it's necessary to let them observe the beneficial outcomes created by AR educational apps. As a result, the observability variable is examined so that the hypothetical effect can be confirmed.

Professionals in the educational field are increasingly attempting to offer pupils real-life experience by expanding the teaching and learning session in real environment contexts. However, real-life experiences and practical exposure and experience are not always feasible due to various reasons (Panda & Tripathy, 2021). For example, it's difficult to expose students to specific geographical structures of a place that is located far away from the educational institution. In attempting to encourage the usage of AR educational apps, the app providers need to make potential users be aware of AR's benefits and the perceived value of AR. In confirming such hypotheses, this study examined the effects created by Gen-Z's awareness and perceived value of AR educational apps.

To solve the problems related to relative advantage, compatibility, complexity, trialability, and observability; the theory of diffusion of innovation (DOI) is used as the basic theory. In solving the problem related to perceived value

and awareness, the DOI model was modified by including the two additional variables.

1.3 Research Questions

i. How do relative advantage, compatibility, complexity, trialability, and observability relate to augmented reality educational app usage intention among gen-z?
ii. How do perceived value and awareness relate to augmented reality educational app usage intention among Gen-Z?

1.4 Research Objectives

In general, the purpose of this research is to determine the behavioral factors that have been influencing the augmented reality educational app usage intention among Gen-Z in Malaysia. Specifically, this study intends:

i. To examine how relative advantage, compatibility, complexity, trialability, and observability influence the augmented reality educational apps usage intention among gen-z.
ii. To examine how perceived value and awareness influence the augmented reality educational app usage intention among Gen-Z.

1.5 Research Significance

1.5.1 To Policy Maker

Malaysia is in the fourth industrial revolution era in which companies are integrating new technologies such as the Internet of Things; cloud computing and analytics; and artificial intelligence into their production and manufacturing facilities for products and services improvement and distribution (Rise Malaysia. my, 2022). Therefore, it is expected that the use of virtual reality and AR is expected to progress soon in Malaysia.

The largest AR app used by worldwide people including Malaysian related to the launch of Pokemon Go in 2016, in which the AR system facilitate players to hunt and capture Pokemon creatures in real-time anywhere by viewing their smartphones (Celcom, 2020). In facilitating visitors to understand selected historical events and products, the Muzium Negara in Malaysia has just launched an AR mobile app. Visitors can download the app on their smartphone so that they can view the information about the shown products or events during their visit to the museum (Rise Malaysia. my, 2022). Ikea has launched its AR app in overseas outlets that allow potential buyers to plan how to decorate a place setting by scanning and placing specific Ikea products from the Ikea catalog into the place (Celcom, 2020). The Ikea Place AR app is expected to be launched in Malaysia soon. Social media platform introduces social media AR apps like Snapchat that allow users to add special effects to themselves or other users through their mobile devices like transforming a person into a princess (Celcom, 2020).

To conclude, AR technology has been applied in entertainment, recreation, shopping, and social communication sectors in Malaysia, but AR is not widely applied in the education sector yet in Malaysia (Rise Malaysia. my, 2022) and less developed country like Nigeria (Oke & Arowoiya, 2021). Such a phenomenon is considered weird because worldwide younger generations, including the Malaysian gen-z, have the ability in handling various technological apps and devices, and therefore using AR for teaching and learning purposes is feasible (Yusof, Jima'ain, Rahim, & Abuhassna, 2022). Also, the Malaysia Education Blueprint (MEB) 2013–2025 has launched a policy of using ICTs to improve the quality of teaching and learning in Malaysia (Nordin & Daud, 2020).

Furthermore, various ICT applications like online classes are introduced and implemented during the Covid19 pandemic from 2020 to 2021 in order to ensure students residing in any location can continue their education (Yusof, Jima'ain, Rahim, & Abuhassna, 2022). Therefore, instructors or teachers, and students have been exposed to and getting more familiar with using ICTs which are considered new to some people. In upgrading an educational institution's reputation, education

service providers alert that they need to equip their front liners like lecturers with the latest technology knowledge.

This study, therefore, examined the AR usage intention among the gen-z because their readiness in adopting AR technology is a gateway to leap away from the practicing of conventional teaching and learning methods that encourage students to be more inclined to self-learning, self-access, and self-paced education (Nordin & Daud, 2020) which eventually able to transform them as productive nations that help Malaysian to become a developed country.

In summary, the authors aim to help the government and educational policymakers better understand the behavioral factors that have been influencing Gen-Z's intentional usage behavior. The current research model and study results also can provide useful information to them in planning tactical strategies that can increase Gen-Z's AR usage interest and intention.

1.5.2 To Academic

The DOI model has been widely applied in technology adoption and in worldwide studies and the results show that different groups of respondents are influenced by a different set of behavioral variables in the same and different study contexts. For example, the complexity of a technological system was not hypothetical significant related to the adoption of Islamic banking (Ali & Puah, 2017), Takaful insurance (Ali, Raza, Puah, & Amin, 2019), and shopping applications (Jiang, Wang, & Yuen, 2021) behavior.

This study, therefore, developed a research model based on the DOI model because possible problems detected during the preliminary study show that the DOI variables are possible indicators that can explain the current study respondent's behavior. The main study result therefore can provide useful indications to researchers of the significant effect created by each DOI variable. Future studies can compare their study with current study results so that meaningful messages that explain the differences can be informed for academics noting and further action.

On top of that, past researchers incorporated the testing of additional variables like awareness of Islamic banking technology (Ali & Puah, 2017), attitude toward the use of shopping applications (Jiang, Wang, & Yuen, 2021), and perceived risk (Al-Jabri & Sohail, 2012). Similarly, this study also incorporates the testing of two additional variables that coincide with the identified problem statements for testing in order to generate a more robust result that explains Malaysian gen's AR usage intention.

1.6 Organization of the Project

The main purpose of this study is to examine the AR app usage intention for education among Malaysian gen-z, using the diffusion of innovation (DOI) as the basic theory of this study. The background education learning method in Malaysia is the main topic of discussion in Chapter 1. In order to formulate suitable study questions and research objectives, it is necessary to identify the issues that have led to the low intention to use AR in education. Chapter 2 discusses how the current study differs from pertinent prior studies in order to guarantee that the uniqueness of the study is justified. The idea that serves as the foundation for this study, the diffusion of innovation (DOI), is also examined. On top of that, past studies' conceptual frameworks were critically analyzed, so that the literature gaps can be identified and filled. Subsequently, the proposed conceptual framework and development of current hypotheses are presented.

Chapter 3 is focusing on explaining the current research design, data collection methods, and data analysis methods in detail as well to ensure the collected data is valid and reliable. In Chapter 4, the descriptive result of the distribution of current respondents' demographic profiles is discussed. To support the current study's hypothesis, inferential statistical results from reliability analysis, correlation tests, multiple linear regression analyses, and other procedures are presented. The conclusion and implications derived from the main study's results to academics and policymakers are well-discussed in Chapter 5. There is also a

discussion of study limitations, explanations for each supported and unsupported hypothesis, and suggestions for future researchers.

CHAPTER 2 LITERATURE REVIEW

2.1 The Theory of Diffusion of Innovation's Theoretical Framework

The Theory of Diffusion of Innovation (DOI) relates to employees' acceptance of a new system or technology applied by organizations. Rogers (1983) explained the current and potential user's reactions toward the innovation of technology are shared through specific channels over time among specific members of a social community. The DOI theory is essentially a social process in which subjectively perceived information about a new idea is communicated and rests on the premise that a new idea, practice, or object has perceivable channels, times, and modes of being adopted by individuals or organizations. Rogers described innovation using five dimension perspectives: relative advantage, compatibility, complexity, trialability, and observability.

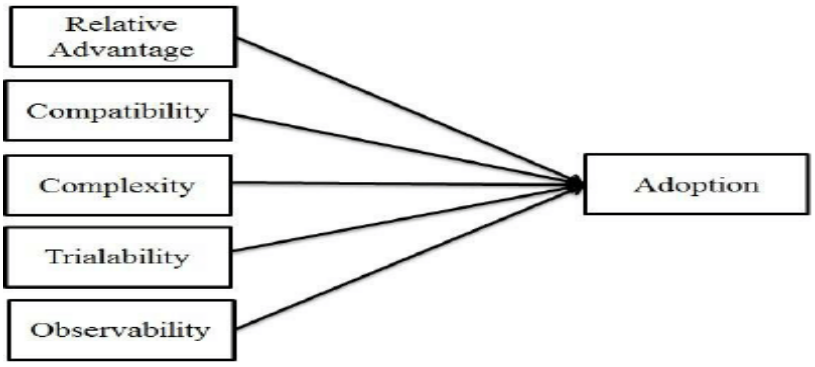

Figure 2.1: The Theoretical Framework of Theory of Diffusion of Innovation

Source: Rogers (1983)

Relative advantage is the degree to which an invention can provide more advantages than the replaced technology. The degree of relative advantage can be expressed in terms of money, status, convenience, or satisfaction. As a result, the higher the apparent benefit, the faster its acceptance (Rogers & Scott, 1997). Teachers employ technology when they recognize its worth in their instruction

(Finley, 2003; McKenzie, 2001; Parisot, 1995; Spotts, 1999). To successfully integrate technology into teacher education courses, teacher education faculty must recognize the importance of offering beneficial experiences for both themselves and their students (Schmidt, 1995).

Compatibility is whether an innovation is regarded to be compatible with the existing values, prior experiences, and requirements of potential users. A more suitable concept is less ambiguous to the potential adopter. As a result, the more compatible an invention is with the existing social structure, the faster it will be adopted since individuals will not need to accept a new value system as an initial step. Whether an invention is considered as difficult to understand and use is referred to as its complexity. Simpler ideas, according to the notion, are accepted more quickly than difficult ones because intricate concepts frequently need individuals/adopters to first gain new information and abilities, which can then enable them to grasp the new idea (Rogers & Scott, 1997). According to Rogers, in contrast to the other criteria, complexity is adversely connected with the rate of adoption. As a result, an innovation's excessive complexity is a significant barrier to its adoption.

Whether an innovation can be tested, particularly on a small scale, is referred to as trial-ability. An invention that can be tried, especially in stages, symbolizes less uncertainty and anxiety and will thus be embraced more quickly (Rogers & Scott, 1997). Furthermore, trialability is positively connected to the rate of adoption. The more times an invention is tested, the faster it gets adopted. Reinvention may occur during the testing of the innovation, as outlined in the implementation stage of the innovation-decision process. The potential adopter may then adapt or modify the invention. Increased reinvention may result in faster innovation uptake. Another crucial aspect in the acceptance of an invention is the vicarious trial, which is especially useful for late adopters. However, Rogers claimed that earlier adopters value the trialability of innovations more than later adopters.

According to Rogers (2003), observability is whether the outcomes of an innovation are visible to others. Peer observation is the most important motivator

for technological adoption and diffusion (Masci et al., 2019). Using AR technology seeks to provide customers with a new perspective on the product's usage. Customers will be able to see the finished product; for instance, while purchasing clothing using AR, shoppers may digitally try on dresses and examine them from various angles utilizing real-life features. Potential adopters are less likely to accept an invention if they are ignorant of it or do not see it being used by their peers.

The DOI variables - relative advantage, compatibility, complexity, trial-ability, and observability of an innovation - may individually or combined influence its adoption or non-adoption.

According to Moore and Benbasat (1991), individuals and organizations must accept new information systems (IS) in order to sustain and advance in the future technological world. As a result, Moore and Benbasat (1991) established a refined IDT model as a tool for studying the initial adoption of IS by individuals in an organization. This theory posits seven-dimensional variables that drive IS adoption: relative benefits, ease of use, image, visibility, compatibility, result demonstrability, and voluntarism. Ease of use is the extent of the difficulty or easiness of using a new invention. Visibility is the extent to which others in the organization are using the system. Image is the ability to which the application of innovation is seen to improve one's image or standing in one's social system. Result demonstrability is the tangibility of the innovation's outcomes, particularly their observability and communicability. Voluntarism is the extent to which the usage of the invention is regarded to be voluntary or of one's own choice.

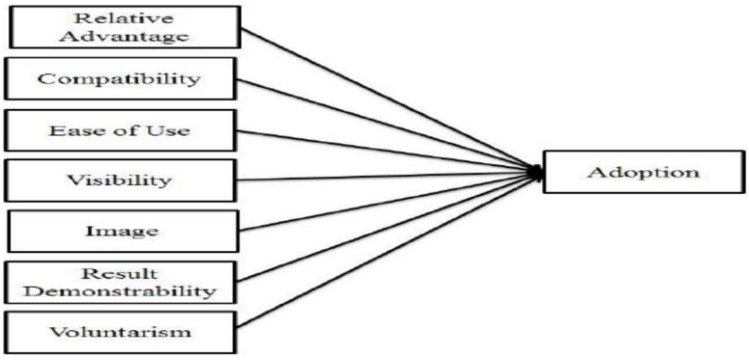

Figure 2.2: The Theoretical Framework of 1st Refined Theory of Diffusion of Innovation

Source: Moore and Benbasat (1991)

Following the refinement of the IDT by Moore and Benbasat (1991), Rogers updated this theory by arguing the following five-dimensional variables – relative advantage, compatibility, complexity, trialability, and observability – create antecedent effects on the perceived attributes of innovation variable which eventually determine the rate of adoptions of the studied innovative product (Rogers, 1995). Also, three additional predictor variables: communication channels, social contact, and effects of change agents are added to the updated model (see Figure 2.3). Communication channels refer to mass media and interpersonal channels that are used to spread an idea. Social context can be a potential adopter's social network, opinion influencers within that network, or organizational attributes. The effort of change agents shows adopters' tendency to accept an innovation when they believe change agents are homophiles to them and vice versa when the change agent are considered heterophonies.

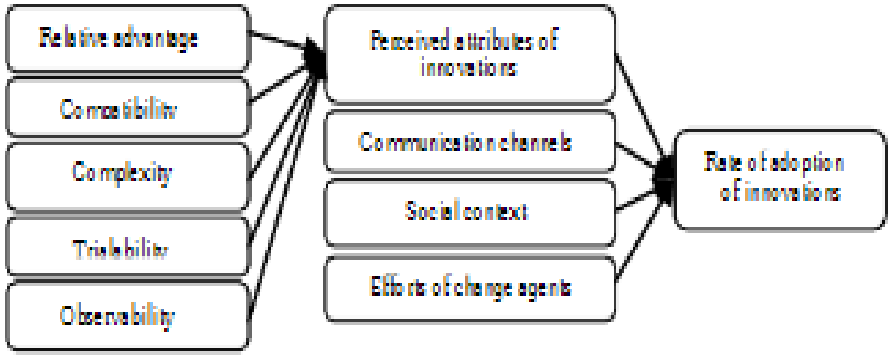

Figure 2.3: The Theoretical Framework of 2nd Refined Theory of Diffusion of Innovation

Source: Rogers (1995)

In 2003, Rogers further explained that more antecedent variables can create a separate direct effect on selected diffusion factors – perceived attributes of innovations and attributes of the social system. A social system refers to a group of interconnected units (can be in the form of individuals, informal groups, organizations, and/or subsystems engaging in cooperative problem-solving to achieve a common purpose (Rogers, 2003). Also, two independent predictor variables: communication channels and time create a direct effect on the adoption of innovation behavior (see Figure 2.4). The perceived attributes of innovations and social systems are characterized as "an idea, behavior, or item seen as a novel by a

person or other unit of adoption" of an innovation or a social system context setting (Rogers, 2003). This model assumes that if the majority of technophile users accept the technology, the diffusion process may be initiated, and other users will follow suit (Pasquier, 2012). The third element, "Time," is related to the invention-decision process, innovativeness, and pace of acceptance of an innovation.

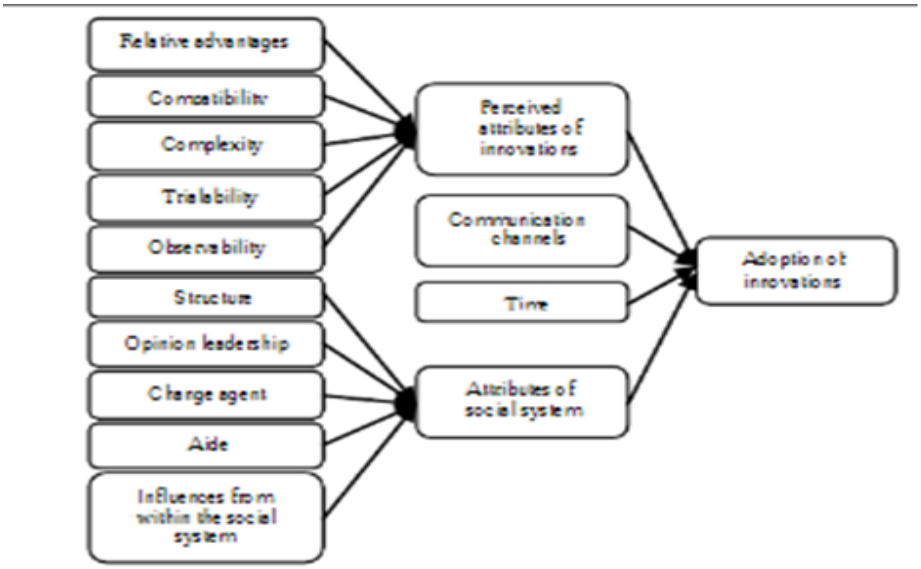

Figure 2.4: The Theoretical Framework of 3rd Refined Theory of Diffusion of Innovation

Source: Rogers (2003)

This study proposes to use the original DOI developed by Rogers in 1983 in response to the preliminary study result. The DOI model is modified because so that a comprehensive result can be developed to solve problems that are detected in the preliminary study which are related to the five original DOI variables and additional variables which are perceived value and awareness. Refer to Figure 2.5

2.2 Overview of the Theory of Diffusion of Innovation Research Models

Past studies have adopted the DOI model in developing their conceptual research models (see Table 2.1). Perceived value is an independent variable that has been incorporated into the DOI model as an independent predictor variable. Perceived value is positively related to the adoption of AR shopping apps (Eyüboğlu, 2011) and experiential marketing (Paris, 2010). Consumer perceived value is determined by the customer's experience and knowledge, and it is an important aspect in attracting new consumers and retaining existing ones.

In examining consumer acceptance or adoption of an invention, the consumer's level of awareness is tested as another independent predictor variable. For example, customer awareness of specific innovative technology in an insurance service, takaful (Ali et al., 2019), or performances of specific products (Ali & Puah, 2017) were predicted to be positively related to respondents' intentional behavior. Past studies model that incorporated both additional variables into the DOI model is limited published in UTAR's library journal and Google Scholar databases. Therefore, the current research model serves to enrich the DOI original model.

Table 2.1: Past Theory of Diffusion of Innovation Studies

Authors' Name (research area)	Tested Variables	Main Results
Ali & Puah, 2017. (Acceptance of Islamic banking as innovation in Pakistan).	IV: DOI constructs, Additional IV: customer awareness DV: The adoption of Islamic banking	All DOI and additional constructs relate to the DV positively, except complexity has a negative impact on DV.
Jiang, Wang, & Yuen, 2021. (Usage of AR for shopping application and the influence of attitude, value, and characteristics of innovation).	IV: DOI constructs Mediating variable: Attitude DV: Intention to use ARSP	Except Complexity all of the IV have positive and significant impact on DV
Ali, Raza, Puah, & Amin, 2019. (Consumer acceptance toward Takaful insurance in Pakistan)	IV: DOI constructs Additional IV: Consumer awareness, Religiosity	All the DOI constructs have a positive significant effect on DV, except Complexity

	DV: The adaption of takaful products	
Al-Jabri & Sohail, 2012. (Mobile Banking Adoption)	IVs: DOI constructs Additional IV: Perceived risk DV: Mobile banking adoption	All the variables have positive impact except Complexity and Perceived risk
Embi, Gabarre, S., Gabarre, C., Hamat, & Din, 2014. (Evaluating the Level of Diffusion of Social Networking Sites among Malaysian University Students).	IVs: DOI constructs Mediating variable 1: Attitude DV : Preference Behaviour	All the IVs have positive impact on DV except Complexity. Observability had significant impact on DV.

2.3 Concept Framework

Based on the DOI framework and the findings of previous investigations, the following conceptual framework is provided for this study. Refer to Figure 2.5.

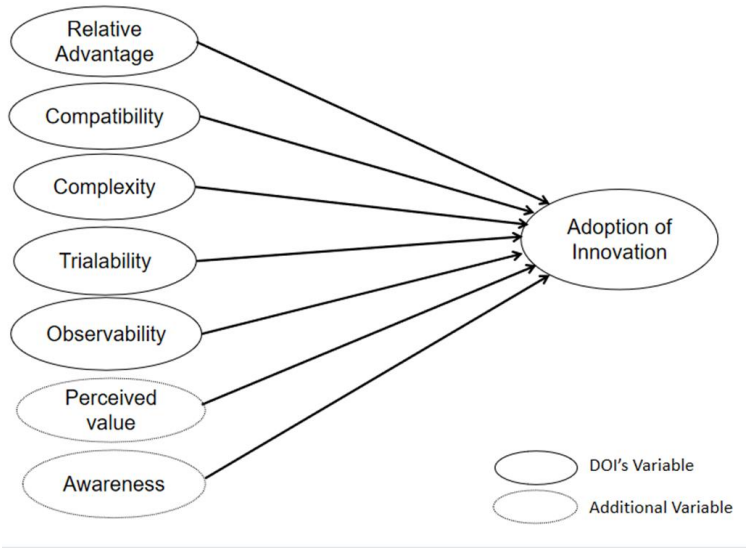

Figure 2.5: Current Research Model

In synchronizing the original definition explained in the original DOI model into our study context, we define the study variables as follows: relative advantage as gen-z's perceived advantage that can be gained from the use of AR Apps. Compatibility refers to Gen-Z's perception of whether the use of AR apps can map their expectation. Complexity refers to Gen-Z's perception of the difficulty that they may face upon using the AR apps. Trialability refers to Gen-Z's expectation of

testing the usability of the AR prior to the actual usage. Observability shows the significant result that Gen-Z expected to obtain upon using AR for education. Perceived value refers to gen-z's perception of the positive or negative values that can be generated by using AR in education. Awareness refers to the gen-z's ability to sense the availability and their knowledge about AR in education.

2.4 Hypotheses Development

2.4.1 Relative Advantage and Augmented Reality Apps Usage Intention (H1)

In a study, the relative advantage is a key indicator of innovation uptake and application (Alam, 2022). E-commerce companies use new innovations like AR because the companies need to be technological proficiency (Chandra, 2018; Chung, 2019). But, in Vakaliuk's (2021), study, the result shows that relative advantage is not a significant variable because lack of a "game loop" or "game cycle," as in other engines, where each game object might have a script or numerous scripts, its own set of events, and its own game cycle and a peculiar and occasionally challenging visual editor, which might be problematic for inexperienced coders. In education, the syllabus of courses and learning outcomes are standardized in order to achieve an institution's vision and mission. Therefore, the authors project that if AR provides a more relative advantage to Malaysian generation z, the higher the usage intention will be.

H1: The relative advantage of augmented reality is positively related with Malaysian Gen-Z's usage intention.

2.4.2 Compatibility and Augmented Reality Apps Usage Intention (H2)

Online research synchronized the AR compatibility of the studied objects as a desktop-based robot that behaves as a tutor to students and as a versatile agent with access to the physical and virtual worlds (Villanueva, 2021). All major 3D formats are incorporated in AR settings, and tools for format conversion are readily available (Ginters, 2013). According to Vogt (2013) and Hanna (2018), the widespread use of AR applications in scientific papers that are incompatible with printed content is severely constrained by the lack of clarity around their long-term durability. Thus, when an AR technological system has a compatibility feature that can meet users' expectations, the authors predict that the compatibility and the AR usage intention variables are positively related.

H2: The compatibility of augmented reality is positively related to Malaysian Gen-Z's usage intention.

2.4.3 Complexity and Augmented Reality Apps Usage Intention (H3)

Despite the computer hardware becoming more sophisticated, the presentation of three-dimensional or hologram images cannot be feasibly presented yet. Contrarily, the display devices programmed in AR can produce hologram images (Pejic, 2014). Therefore, complexity becomes a disadvantageous element that discourages potential users' usage intention (Garzon, 2019). However, gen-z is a highly visual and experiential generation that values authenticity, creativity, and individuality. As AR provides an opportunity for them to express themselves creatively and interact with the world in new ways, which aligns with their values (Hernandez, 2020), their usage intention, therefore, is expected to increase. In other words, the authors predict that when the perceived complexity in using AR lowers, gen-Z's usage intention increases.

H3: The complexity of augmented reality is negatively related to Malaysian Gen-Z's usage intention.

2.4.4 Trialability and Augmented Reality Apps Usage Intention (H4)

Trialability allows users to experience and have hands-on experiments with specific technology systems which thereby increases the rate of innovation adoption (Rogers, 1995). Therefore, for educators to decide whether to adopt AR apps for teaching and learning, it is necessary for the educators to test run the AR applications prior to actual use (Marks, 2022). However, not all applications permitted users to create content on their own (Adelakun, 2015). Nevertheless, the AR app providers are modifying the system applications so that more non-scientific courses like arts and literature can make use of the AR capabilities in enhancing students' interest and understanding of the study subject. Thus, the authors anticipate that if Gen-Z is given the opportunity in trying AR, their usage intention will increase.

H4: The trialability of augmented reality is positively related to Malaysian Gen-Z's usage intention.

2.4.5 Observability and Augmented Reality Apps Usage Intention (H5)

The degree of usability can be defined as the value of each usability factor's effectiveness, learnability, and satisfaction (Brata, 2019). In a past study, gen-z who had used AR apps was performing better than non-users (Moore, 1991). When more gen-z observes AR's beneficial outcomes in helping them to progress in learning, their favorable perception of AR increases (Kopsida, 2016). Similarly, in this study context, if Gen-Z observes the beneficial outcome of using AR, their usage intention will increase because Malaysian gen-z is born in the technology era, and their ability in handling new technology is relatively easier compared to the older generation.

H5: The observability of augmented reality is positively related to Malaysian Gen-Z's usage intention.

2.4.6 Perceived Value and Intention to use Augmented Reality Apps (H6)

The finding shows that early adopters of new technologies are likely to embrace a new innovation if the technology usage outcomes can meet their perceived value (Chung, 2015). At a conference, a large number of tech-savvy groups who were unfamiliar with AR technologies replied that they had never used AR before attending the conference (Lau, 2019). As a result, educators start looking for new technology that could be used in the classroom to enhance student learning and comprehension, particularly in the area of science disciplines (Saidin, 2015). According to Martin (2015), most students felt comfortable when the evaluated innovative system helps them to progress in theoretical and practical learning. Similarly, the authors project that the perceived value of AR will drive the Malaysian gen-z usage intention positively.

H6: The perceived value of augmented reality is positively related to Malaysian Gen-Z's usage intention.

2.4.7 Awareness and Intention to use Augmented Reality Apps (H7)

Gen-Z's awareness will affect the intention to use AR apps. This is because AR makes it easier for pupils to connect and interact with virtual data or objects (Bujak, 2013). Contrary, in Radu's (2014) study, the results show that AR creates a detrimental effect on learning progress in the classroom. Examined students were more involved in role-playing and investigation of the subject matter during the non-AR experience or when the teacher was present. As technology is growing rapidly, the applications of AR, therefore, is improving too. As AR is designed to serve as an innovation tool that aims to enhance students' learning progress, we anticipate that the gen-Z's usage tendency will increase when they become more

aware of the niche capacity in using AR. In other words, awareness of the AR beneficial outcomes drives the gen-z usage intention.

H7: The awareness of augmented reality is positively related to Malaysian Gn-Z's usage intention.

CHAPTER 3 METHODOLOGY

3.1 Research Design

The quantitative approach involves the gathering and interpreting of numerical data and data results. The quantitative result has been used in studies to discover distributive patterns and to confirm the hypothetical causal linkages so that the results can be generalized to larger groups or represent the population's behavior (Bhandari, 2020). Quantitative data is collected using a questionnaire survey with close-ended questions so that respondents' feedback about their experiences and perspectives can be quantified easily.

A questionnaire survey has been used to measure the DOI and additional variables in past studies to confirm the studies' hypothetical relationships between variables. As a result, an exploratory study to confirm the variable's items is not required. Just like past researchers, the authors collect quantitative data.

3.2 Sampling Design

Malaysia's digitalized natives, gen-z, are the first generation to have grown up during the internet evolution and were born between 1995 and 2012 (Salleh, 2017). Gen-z accounts for 26% of Malaysia's population and has distinct features that distinguish them from the millennials and boomers generations, notably in the way they consume information and react to companies. The estimated count of the Malaysian population is about 32,370,300 and approximately 29 percent worth 9,387,300 are in the gen-z category in 2019 (Department of Statistics, 2019).

This study targets Gen-Z because most of them are students and they are technologically savvy (Landry et al., 2018). As the target population's aging range is a subset grouping of individuals aged from 10 to 27, the authors safely conclude that the estimated population count for the target population is greater than 9,387,300. Using Morgan's table, the sample size (table below) for this project is 384 if the population size is 250,000 or above.

Table 3.1: Morgan Sample Size Table

TABLE FOR DETERMINING SAMPLE SIZE FROM A GIVEN POPULATION

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	246
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	351
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	181	1200	291	6000	361
45	40	180	118	400	196	1300	297	7000	364
50	44	190	123	420	201	1400	302	8000	367
55	48	200	127	440	205	1500	306	9000	368
60	52	210	132	460	210	1600	310	10000	373
65	56	220	136	480	214	1700	313	15000	375
70	59	230	140	500	217	1800	317	20000	377
75	63	240	144	550	225	1900	320	30000	379
80	66	250	148	600	234	2000	322	40000	380
85	70	260	152	650	242	2200	327	50000	381
90	73	270	155	700	248	2400	331	75000	382
95	76	270	159	750	256	2600	335	100000	384

Note: "N" is population size
"S" is sample size.

Krejcie, Robert V., Morgan, Daryle W., "Determining Sample Size for Research Activities", Educational and Psychological Measurement, 1970.

This study uses the snowball sampling method in order to identify and invite hidden population groups that could be difficult to be reached the authors. Also, the absence of a sampling frame makes it difficult for the authors to employ any probability sampling methods. In order to reduce the possibility to be transmitted Covid-19, the authors distribute an e-questionnaire to young working adults in Malaysia that are permanently residing in different places.

The snowballing process began with the dissemination of the e-questionnaire to respondents within current researchers' reach, such as friends and family, using e-social platforms such as WhatsApp and Google Forms. The friends and family members were then asked to assist the authors in disseminating the e-questionnaire to their family or social network that might fulfill the description of the current study population. In the second phase, respondents were requested to pass over the e-questionnaire to their network that shares similar demographic characteristics as defined in this study. Besides, the respondents are requested to join a WhatsApp group by link before they complete the survey so that the authors can assist any respondents that need further assistance or clarification. The snowballing process stop upon the collection of 385 answered questionnaires.

3.3 Data Collection Methods

In designing the questionnaire item statements, the authors modified the statements used in past studies. After that, the authors began the pre-test procedures – the modified statements were checked by academic supervisors. Modifications were done according to the feedback given by the academic supervisors (response from the pre-test expert is attached in Appendix 1).

In the following stage, the authors conducted a pilot study survey on five Malaysian gen-z ages 15 to 24 years old. Similar to the pre-test procedures, the authors requested the pilot study participants provide their feedback regarding their understanding of what each item aimed to measure, and modifications of related statements were made in response to the pilot respondent's feedback. Finally, the revised questionnaire was given back to the pilot respondents for answers. The main purpose is to check whether the pilot study respondents were providing consistent responses regarding the items used to measure the same variable. As the reliability coefficient score for each variable is equivalent to or higher than the threshold value of 0.6 (see Table 3.2), the questionnaire draft was then finalized for the main study (see Appendix 2).

Table 3.2: Pilot Study Reliability Test Results

	Cronbach Alpha Score	No. of items
Relative Advantages (RA)	0.837	3
Compatibility (CB)	0.842	4
Complexity (CL)	0.858	4
Trialability (TB)	0.838	5
Observability (OB)	0.882	4
Perceived Value (PV)	0.904	5
Awareness (AW)	0.815	5
AR usage intention	0.709	3

The finalized item statement Is shown in Table 3.3. The finalized questionnaire has two sections: A and B. Section A aims to collect respondents' demographic data. Section B shows all the item statements that are meant to measure the seven Ivs and one DV, and respondents are required to tick only one of the 5-point Likert scale which ranges from strongly disagree (shown by point 1) to strongly agree (shown by point 5).

Table 3.3: Finalized Item Statements for Main Study

Variable	Measurement Items	Source of adoption
Relative Advantages (RA)		Dacko, 2017
RA1	Augmented Reality (AR) education apps provide good experiential learning value.	
RA2	Augmented Reality (AR) education apps provide novel (or innovative or unique) experiential benefits in learning experiences.	
RA3	Augmented Reality (AR) education apps can change users' learning behaviors.	
Compatibility (CB)		Moore,1991
CB1	The use of Augmented Reality (AR) education apps is compatible with the current delivery methods used by education service providers.	
CB2	The use of Augmented Reality (AR) education apps is compatible with my current learning situation.	
CB3	Using an Augmented Reality (AR) education app fits well with the way I like to learn.	
CB4	Using an Augmented Reality (AR) education app fits into my learning style.	
Complexity (CL)		Rauschnabel, 2016; Moore,1991
CL1	I think it is difficult to use the Augmented Reality education apps.	
CL2	I think a number of task/ administrative procedures need to be performed when using the Augmented Reality education apps.	

CL3	I think it is difficult for me to remember how to perform the required tasks when using the Augmented Reality education apps.	
CL4	Using an Augmented Reality education app can be frustrating.	
Trialability (TB)		Moore,1991
TB1	I should be given the opportunity to try various Augmented Reality education applications.	
TB2	The providers of Augmented Reality education apps should give me sufficient time period in experiencing the various uses of the education apps.	
TB3	The providers of Augmented Reality education apps should assist me in test running the applications.	
TB4	I need to have a proper try out session before deciding whether to use the Augmented Reality education apps.	
TB5	The providers of Augmented Reality education apps should give me sufficient trial time period so that I can see what the apps could do.	
Observability (OB)		Moore,1991
OB1	I should be able to view the outcomes or consequences clearly upon using the Augmented Reality education apps.	
OB2	I believe I could communicate to others the outcomes or consequences of using Augmented Reality education apps.	
OB3	I think I won't have the difficulty telling others about the result of using Augmented Reality education apps.	

OB4	I think I won't have the difficulty in explaining whether it is beneficial or not beneficial to use Augmented Reality education apps.	
Perceived Value (PV)		Moore,1991
PV1	The Augmented Reality education apps provide good value to users.	
PV2	The Augmented Reality education apps improve users' learning ability.	
PV3	The Augmented Reality education apps increase users' esteem in performing specific work.	
PV4	The Augmented Reality education apps increase the profile or representation of the user's.	
PV5	Having Augmented Reality education apps is a status symbol in my organization.	
Awareness (AW)		Moore,1991 Wei, 2021
AW1	I am aware people are using the Augmented Reality education apps.	
AW2	I have seen the use of Augmented Reality education apps outside my education institution.	
AW3	It is easy for me to observe how others use the Augmented Reality education apps in my school.	
AW4	I am aware that Augmented Reality education apps can be used as teaching aids.	
AW5	I know that Augmented Reality education apps can be applied in various fields like research.	
DV: Intention to use Augmented Reality Apps		
Int1	I would like to experience the usage of Augmented Reality Apps in my education institution.	Balog,2010

Int2	I intend to use Augmented Reality Apps for learning	
Int3	I will recommend to the gen-Z to use Augmented Reality Apps for learning.	

3.4 Data Analysis Method

The collected quantitative data is analyzed using descriptive and inferential statistical methods. Before making explicit inferences, descriptive statistics are utilized (Forbes, 2015). Descriptive data is categorized into a few categories that aim to explain the distribution pattern of related demographic variables such as gender, age, ethnicity, and academic degree.

Inferential statistical data is used to infer population characteristics from data collected from a representative sample. In order to ensure the data is valid and reliable, a series of statistical tests were carried out. First, a reliability test was performed to confirm the dependability of the gathered data. The Cronbach alpha score is affected by the number of tested items, item inter-relatedness, and dimensionality. The threshold Cronbach alpha score of 0.70 is recommended if the sample size is big (Tavakol & Dennick, 2011). Doloi et al (2011). A low alpha value however is acceptable when the sample size is small or heterogeneous conceptions from one respondent in a small group create a big impact compared to larger groups.

The linearity and normality of the acquired data were tested by plotting a Q-Q plot for each variable's data (Djurovic et al., 2000). If the difference between the estimated predicted values is not much different from the respective actual values provided by each responder for the same item, the data of the variable then is deemed considered as normally distributed.

The linear association between each IV and the DV is measured using correlation analysis (Gogtay, 2010) by computing Pearson's correlation coefficient score. Correlated variables show that the data of the variables tend to move in a specific direction, either positively or negatively associated; but the correlation relationship doesn’t signify that the data of one variable is causing another variable’s data to change. Therefore, in testing the causal relationship, linear regression analysis was performed to confirm the hypothetical relationship between each IV and the DV. The regression score shows the proportion of the variance in the DV that can be explained by the respective IV. In other words, the regression score indicates how well the data match the regression model.

The issue of multicollinearity should be avoided. Each IV should be functioned independently and has a significant association with one another. The VIF test was used to determine how much the IVs are correlated. A VIF coefficient score of fewer than 10 shows that the IVs are not substantially associated. If the IVs are multicollinearity, researchers need to remove one of the IVs or merges both data sets as one set of data.

The T-test result shown in the regression result table assesses the significant effect created by each IV at a precision level of 0.05. Using the regression stepwise method, the system will run the regression in a few rounds and the process stops once no more significant IV is detected. The final round of stepwise results shows which IVs create a significant and non-significant effect on the DV. The significant variable reflects the support of the respective hypothesis and vice versa for the non-significant variable. The multiple linear regression equation for the project is provided below:

$$Y = a + bX1 + cX2 + dX3 + eX4 + fX5$$

Where:

Y = Dependent variable (Intention to use Augmented Reality Apps)

X1: IV1 - Relative Advantage

X2: IV2 - Compatibility

X3: IV3 - Complexity

X4: IV4 - Trialability

X5: IV5 - Observability

X6: IV6 - Perceived Value

X7: IV7 - Awareness

a: Intercept or constant value

b,c,d,e & f: Regression coefficient of X1. X2. X3, X4, & X5.

3.5 Ethical Consideration

Every research project, regardless of its economic, political, social, or health implications, must be conducted ethically. According to the UTAR's ethical research policy, all research information, including questionnaires or proposed experiments (regardless of study disciplines or whether quantitative or qualitative in character), must be evaluated by members of the university's ethical committee before data can be collected. The committee's role is to ensure researchers will collect data using an ethical approach that covers the way data is collected and disposed of after the proposed project is completed.

The authors have submitted the ethical clearance form and approval is obtained from the ethical committee board. The personal data protection statement (PDPS) was appended to the first page of the questionnaire to reassure respondents that their biographic identity would be kept as private and confidential as possible. To guarantee that this is not a scam project, the current author has included personal contact information in case responders have any questions.

CHAPTER 4: DATA ANALYSIS AND RESULTS

4.0 Introduction

This chapter focuses on the presentation and discussion of data findings which are from 385 samples. The following sub-topics discuss the descriptive and inferential statistical results.

4.1 Descriptive Result

4.1.1 Respondent's Demographic Result

This study targets young adults or Gen-Z, aged 10 to 27, living in Malaysia. Table 4.1 shows that relatively, more female respondents (57.1%) participated in answering the questionnaire compared to male respondents (42.9%). Almost all the respondents from the 16-22 age group, accounted for 90.6%. This is because we apply the snowball sampling method, so if the first person we find is a Chinese and/or age between 16 and 22, they have tendency to pass the questionnaire to their friend with similar background.

There are a few types of respondents for our questionnaire which are Malay, Chinese, Indian, Iban, Portuguese, and Sino Kadazan. Most of the respondents are Chinese (68.8%) compared to the Indian, Malay, and Indigenous respondent groups. This is because the method that we collect respondent is snowball sampling method then the Chinese respondent will send to their Chinese friend.

Table 4.1 Demographics Profiles of Current Respondents

	Frequency	Percent	Cumulative Percent
Gender			
• Male	143	40.6	40.6
• Female	209	59.4	100.0
Total	352	100.0	
Age			
• 10-15	1	.3	.3
• 16-22	322	91.5	91.8
• 23-27	29	8.2	100.0
Total	352	100.0	
Ethnicity			
• Malay	1	.3	.3
• Chinese	343	97.4	97.7
• Indian	5	1.4	99.1
• Iban	1	.3	99.4
• Portuguese	1	.3	99.7
• Sino Kadazan	1	.3	100.0
Total	352	100.0	

4.2 Inferential Analysis

A series of statistical analyses were carried out before confirming the current study's hypotheses.

4.2.1 Reliability Result

The reliability coefficients for each studied IV and the DV are shown in Table 4.2 and all are higher than the threshold value of 0.7. The result suggests that each participant had provided their responses on items used to measure the same variable in a consistent manner (Jim, 2023).

Table 4.2 Reliability Test's Result for Main Survey Data

Variable's name	Cronbach's Alpha Score	Number of items
Relative Advantage (RA)	0.860	3
Compatibility (CB)	0.843	4
Complexity (CL)	0.831	4
Trialability (TB)	0.887	5
Observability (OB)	0.827	4
Perceived Value (PV)	0.873	5
Awareness (AW)	0.811	5
Augmented Reality Apps Usage Intention	0.851	3

4.2.2 Normality of Data Distribution

The plotted Q-Q plot of each variable show that the data for each variable are not widely different from its respective expected value (see Figure 4.1).. Also, the plots do not show a non-linear trend pattern, such as a U-shape or internal U-shape pattern. Therefore, the data of each variable is considered as normally distributed which supports the use of linear regression analysis that is discussed in the sub-topic 4.2.4.

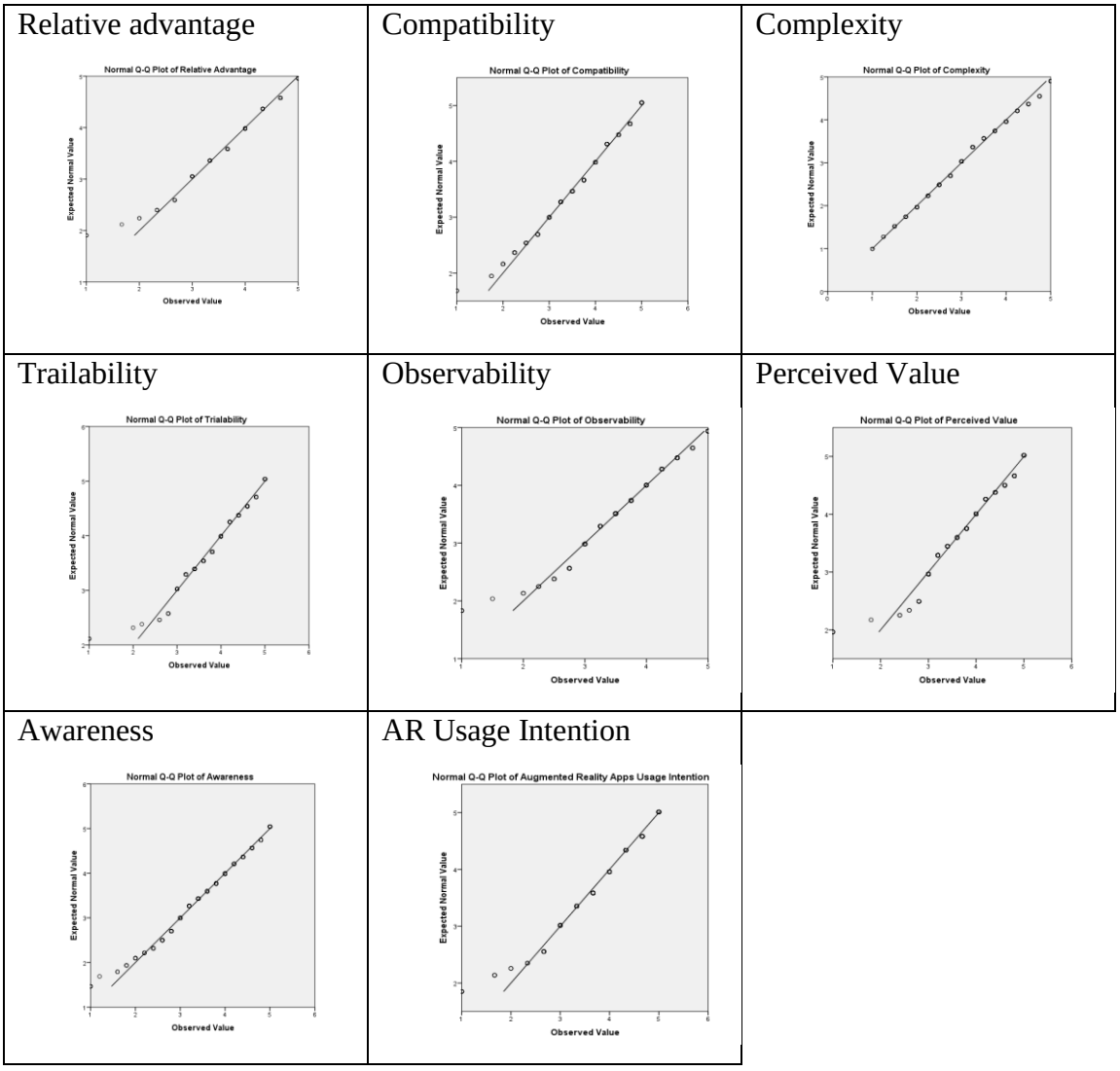

Figure 4.1: QQ Plots for Main Study Data

4.2.3 Correlation Result

Before examining the causal relationship, the authors examined the correlation relationship between each IV and the DV. Simply, a correlational relationship shows that the data from the two evaluated variables are synchronized or harmonized related. The Person's correlation coefficient score may take on any value between plus and minus one, which defines the direction of the relationship, either positive or negative. Table 4.3 below, shows that all IVs except the complexity variable are moderately associated with the DV. The complexity variable is weakly moderated and associated with the DV. Nevertheless, the correlation result doesn't signify that the IVs are not acting as causal variables.

Table 4.3 The Pearson's Correlation Coefficient Scores

	RA	CB	CL	TB	OB	PV	AW	Int
Relative Advantage (RA)								
Pearson Correlation	1	.653**	.146**	.735**	.610**	.675**	.478**	.653**
Sig. (2-tailed)		.000	.006	.000	.000	.000	.000	.000
N	352	352	352	352	352	352	352	352
Compatibility (CB)								
Pearson Correlation	.653**	1	.146**	.532**	.553**	.664**	.480**	.577**
Sig. (2-tailed)	.000		.006	.000	.000	.000	.000	.000
N	352	352	352	352	352	352	352	352
Complexity(CL)								
Pearson Correlation	.146**	.146**	1	.195**	.230**	.189**	.248**	.191**
Sig. (2-tailed)	.006	.006		.000	.000	.000	.000	.000
N	352	352	352	352	352	352	352	352
Trialability (TB)								
Pearson Correlation	.735**	.532**	.195**	1	.664**	.706**	.434**	.713**
Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000
N	352	352	352	352	352	352	352	352

Observability (OB)								
Pearson Correlation	.610**	.553**	.230**	.664**	1	.708**	.565**	.649**
Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000
N	352	352	352	352	352	352	352	352
Perceived Value (PV)								
Pearson Correlation	.675**	.664**	.189**	.706**	.708**	1	.598**	.773**
Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000
N	352	352	352	352	352	352	352	352
Awareness (AW)								
Pearson Correlation	.478**	.480**	.248**	.434**	.565**	.598**	1	.550**
Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000
N	352	352	352	352	352	352	352	352
Augmented Reality Apps Usage Intention (Int)								
Pearson Correlation	.653**	.577**	.191**	.713**	.649**	.773**	.550**	1
Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	
N	352	352	352	352	352	352	352	352

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

4.2.4 Multiple Linear Regression Result

Table 4.4 shows that four IVs (Relative Advantage, Complexity, Compatibility, and Observability) are omitted or excluded. or removed from the model due to their non-significant effect on the DV's variation.

Table 4.4: Regression's Model Summary Result – Excluded Variables

					Collinearity Statistics		
	Beta In	t	Sig.	Partial Correlation	Tolerance	VIF	Minimum Tolerance
Model 1							
Relative Advantage	.241b	5.463	.000	.281	.545	1.835	.545
Compatibility	.114b	2.528	.012	.134	.559	1.788	.559
Complexity	.047b	1.363	.174	.073	.964	1.037	.964
Trialability	.333b	7.473	.000	.371	.501	1.995	.501
Observability	.205b	4.376	.000	.228	.499	2.005	.499
Awareness	.137b	3.275	.001	.173	.642	1.558	.642
Model 2							
Relative Advantage	.110c	2.260	.024	.120	.412	2.429	.379
Compatibility	.078c	1.830	.068	.098	.551	1.814	.385

Complexity	.026c	.805	.421	.043	.957	1.045	.497
Observability	.107c	2.274	.024	.121	.445	2.248	.399
Awareness	.131c	3.370	.001	.178	.642	1.559	.396
Model 3							
Relative Advantage	.090d	1.853	.065	.099	.404	2.473	.374
Compatibility	.059d	1.405	.161	.075	.541	1.848	.335
Complexity	.008d	.245	.807	.013	.929	1.076	.396
Observability	.071d	1.482	.139	.079	.416	2.406	.354

a. Dependent Variable: Augmented Reality Apps Usage Intention

b. Predictors in the Model: (Constant), Perceived Value

c. Predictors in the Model: (Constant), Perceived Value, Trialability

d. Predictors in the Model: (Constant), Perceived Value, Trialability, Awareness

Basically, the regression results show which (if any) of the IVs are the significant indicators of Malaysian young working adults' intention to purchase private-label brand products. Table 4.5 shows that 66.4% of the variation of the DV has been explained by the following IVs - perceived value, trialability, and awareness. The remaining balance of the DV's variation (33.6%) is explained by external variables, which are not investigated in this study..

Table 4.5: Summary of Regression Result

Model Summary[d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.773a	.597	.596	.50156
2	.808b	.653	.651	.46635
3	.815c	.664	.661	.45958

a. Predictors: (Constant), Perceived Value

b. Predictors: (Constant), Perceived Value , Trialability

c. Predictors: (Constant), Perceived Value , Trialability, Awareness

d. Dependent Variable: Augmented Reality Apps Usage Intention

The ANOVA table shows that at least one of the relevant IVs (perceived value, trialability, awareness) is associated with the DV at the 0.05 level of significance (see Table 4.6)

Table 4.6: ANOVA Table of Regression Test

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	130.396	1	130.396	518.352	.000b
	Residual	88.046	350	.252		
	Total	218.442	351			
2	Regression	142.540	2	71.270	327.704	.000c
	Residual	75.902	349	.217		
	Total	218.442	351			
3	Regression	144.939	3	48.313	228.738	.000d
	Residual	73.503	348	.211		

a. Dependent Variable: Augmented Reality Apps Usage Intention

b. Predictors: (Constant), Perceived Value

c. Predictors: (Constant), Perceived Value , Trialability

d. Predictors: (Constant), Perceived Value , Trialability, Awareness

4.3 Current Developed Research Model

When numerous IVs are closely correlated to one another, multicollinearity issues occur, hence making it hard for the regression equation to separate the independent contributions of each IV. The multicollinearity issue was next investigated by analyzing the VIF score of each variable, as shown in Table 4.7. According to Tiwari (2016), a high VIF value of greater than 10 indicates that the tested IV is highly correlated with other variables in the model. Because all the VIF values for each significant IV are less than 10, the significant Ivs are considered independent or not substantially connected with one another. In short, multicollinearity issues are not addressed in the conceptual model of this study. In determining which IV can explain the variation of the DV at the precision level of 0.05, the regression t-test analysis was carried out. Table 4.7 shows that the perceived value variable has the highest regression coefficient score, followed by trialability and awareness.

Table 4.7: The Regression Coefficient between Each Predictor and the Dependent Variable

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	659	.142		4.645	.000		
	Perceived Value	.837	.037	.773	22.767	.000	1.000	1.000
2	(Constant)	.145	.149		.976	.330		
	Perceived Value	.582	.048	.537	12.056	.000	.501	1.995
	Trialability	.376	.050	.333	7.473	.000	.501	1.995
3	(Constant)	.006	.152		.037	.970		
	Perceived Value	.499	.053	.461	9.338	.000	.396	2.523
	Trialability	.373	.050	.330	7.512	.000	.501	1.996
	Awareness	.134	.040	.131	3.370	.001	.642	1.559

a. Dependent Variable: Augmented Reality Apps Usage Intention

Finally, a normal P-P plot is used to confirm that overall, all the significant IVs and DV have a linear relationship. Figure 4.2 depicts the linear relationship between observed or collected data with the expected value, or the linear relationship between all the significant IVs and the DV.

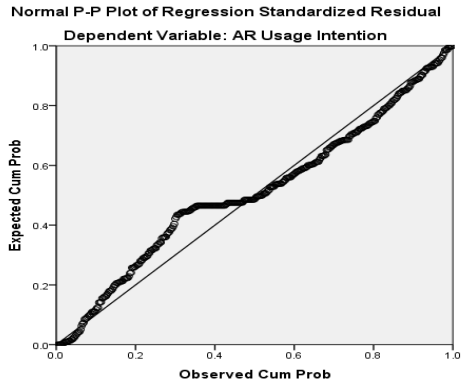

Figure 4.2: The Normal P-P Plot of Regression Standardized Residual

From the t-statistics result (as shown in Model 4 at Table 4.6), the multiple regression equation for this study is shown below.

Intention to use (Int) = 0.074 + 0.515 PV + 0.353 TB + 0.121 AW

where,

Int : AR usage intention

PV : Perceived Value

TB : Trialability

AW : Awareness

Based on the result, the final research conceptual model for this project is shown in Figure 4.3

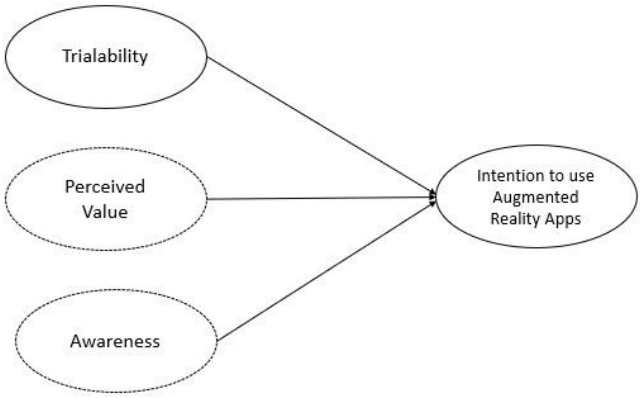

Figure 4.3 Current Developed Research Model

4.4 Conclusion

Throughout this chapter, the results indicate that the reliability requirement is met, data are normally distributed, the significant IVs and DV are linearly associated, and the multicollinearity issues are not an issue in this study model. The confirmation of the current hypotheses is shown in Table 4.8. Three out of seven tested IVs are significantly related to DV.

Table 4.8: The Summary of the Confirmation of Current Hypothesis:

Hypothesis details	Remarks
H1: The relative advantage of augmented reality is positively related to Malaysian Gen-Z's usage intention	Not supported
H2: The compatibility of augmented reality is positively related to Malaysian Gen-Z's usage intention	Not supported
H3: The complexity of augmented reality is negatively related to Malaysian Gen-Z's usage intention	Not supported
H4: The trialability of augmented reality is positively related to Malaysian Gen-Z's usage intention	Supported
H5: The observability of augmented reality is positively related to Malaysian Gen-Z's usage intention	Not supported
H6: The perceived value of augmented reality is positively related to Malaysian Gen-Z's usage intention	Supported
H7: The awareness of augmented reality is positively related to Malaysian Gen-Z's usage intention	Supported

CHAPTER 5: CONCLUSION AND IMPLICATIONS

5.1 Accomplishment of Research Objectives

Two specific objectives are established in response to the preliminary study's findings. The first objective consisting of five hypotheses (H1 to H5) that aim to predict the hypothetical relationship between the DOI variables and the DV. The first hypothesis (H1) that examines the causal relationship between the relative advantage and intentional behavior is not supported. The inconsistent response received from the respondents pertaining to the variable's relationship could be due to the following reason. Students who have experienced AR technology in a non-educational context like games may likely feel that specific relative advantages provided by AR educational apps motivate their intention positively. Comparatively, another group of respondents who have no knowledge about AR at all may find it difficult for them to imagine how AR can help in improving their learning. The result is consistent with the study carried out by Carter and Bélanger, (2005).

From the main study result, the H2 is not supported. Every person has a unique learning style, some may prefer traditional learning methods, and some prefer innovative learning methods. Also, respondents located in the city and rural areas have different perceptions. Schools in rural areas may not have the facilities that allow the schools to provide such innovative services. Such inconsistent behavior and learning environment could have possibly driven the non-significant effect created by the compatibility variable. This is consistent with a past study by Oliveria da Silva et al, (2019).

The H3 is also not supported. Possibly, this is due to not all Gen-Z is familiar with new technology especially when they have a different demographic background. Those that have no experience in using AR in non-educational contexts like games may presume the AR technology is complicated. Contrary, using AR for the first time may not be assumed as a challenging task for those respondents that have been well exposed to new innovative technology. This result is consistent with a study by Blankenberg et al., (2022).

The support of (H4) meanwhile shows that the majority of the main study respondents agree that their intentional behavior increases when they have the opportunity to use AR on a trial basis for a specific time. The result is consistent with some past studies carried out in examining the adoption of virtual reality for higher education (Marks, 2022) and the evaluation of AR systems (Adelakun, 2015).

The result is not supported (H5). As AR is a very new technology in Malaysia, only a limited number of Malaysians have the opportunity to try or use AR. As a result, only a small group of respondents have the opportunity to observe the beneficial outcomes of the use of AR. Meanwhile, there could be a group of Gen-Z respondents who have come across the AR information and they have formed a neutral or favorable attitude toward the use of AR. The such inconsistent reaction is similar to a study carried out by Williams et al., (2020).

In accomplishing the second objective, two hypotheses (H6 and H7) are developed to test the relationship between the additional variables and the intentional behavior. The results show that H6 and H7 are both supported. H6 is supported because most of the respondents appreciate AR if the AR provides good value to them like improving their learning ability and helping them to achieve the esteem level in performing specific work tasks. The support of H6 is consistent with studies that examine AR shopping apps (Eyüboğlu (2011) and AR experiential marketing (Paris, 2010).

The support of H7 is consistent with the following past studies' results: customer awareness of the usage of specific innovative technology in a service like takaful product usage (Ali et al, 2019) and the performance of the specific product (Ali & Puah, 2017). The respondents' intentional behavior increase when they are aware of the functionality of AR, especially in the context of education.

5.2 Implications

5.2.1 Implications for Managerial Decision Maker

This study result can provide useful information to managerial decision-makers in encouraging the Malaysian gen-z to use AR educational apps. The support of H4 implies that the government and AR service providers need to provide a trial opportunities to Gen-Z and provide assistance in running the applications so that they can evaluate their experience. According to Wong, 2020, the majority of students use VR after they were given a trial experience in their practical classes.

Referring to the support of H6, it is necessary to educate Gen-Z about the perceived value of AR. The government and AR providers need to explain how AR can help them to improve their learning skills so that the work productivity of existing and future gen-z manpower increases. Peng's (2013) study results expand the relationship by examining the antecedent effect created by the price factor. The past study result shows that price is a determinant antecedent variable in affecting users' judgment about the study's object's perceived value. Therefore, the AR providers need to develop and distribute the AR using a cost-effective method. The providers can target bigger user groups like higher tertiary institutions that have a count of students. When the number of users is big, the cost per unit will drop. Such incentives will drive potential users to explore the perceived value of AR which eventually increases their usage behavior.

In addition, the support of H7 shows that it is necessary to create AR awareness among Gen-Z as the system is considered a very new innovation system concurrently. Demonstration and trial usage of AR service is one of the effective marketing strategies that can be used to increase Gen-Z's awareness.

5.2.2 Implications for Academic

The DOI has been applied to test banking (Al-Jabari et al., 2012, Ali, Muhammad, Puah, 2017), takaful insurance (Ali & Muhammad, 2019), & social marketing (Embi et al., 2014) systems, but fewer studies have examined all of the DOI predictors in one study, particularly in studies including the intention to use AR apps. So, by investigating the impacts produced by each DOI predictor variable, this study fills the knowledge gap in the literature (Relative Advantage, Compatibility, Complexity, Trialability, and Observability). Also, the perceived value and awareness variables—both of which are influenced by the research's early findings—have been included in the current study model, which has adjusted the DOI.

The DOI model has been frequently used to research intention, and many people have agreed with its ideas. For example, many studies supported that respondents had the tendency to react positively towards the intentional behavior when a favorable attitude was developed (Li, et al., 2019; Nguyen, et al., 2019). The social influence played a significant role in encouraging the respondent’s intention to: (1) purchase green food (Marija, et al. 2015); (2) use the e-purchase facility (Nasbullah, et al. 2015); and (3) robotic restaurant marketing strategies (Hwang et al., 2020).

The outcome demonstrates that DOI, which was overlooked by earlier researchers while applying AR investigations, is still a useful model in predicting current respondents' deliberate behavior. Academics enrich literature with additional variables in this model. The DOI model may be further enhanced, and the updated behavioral model can really provide a more thorough and reliable explanation of the respondents' behavior, as seen by the considerable influence of the AR perceived value variable.

The result doesn’t mean DOI is not an appropriate referred model for AR. The result implies that gen-Z with different demographic backgrounds is likely to act inconsistently towards the effect created by each DOI variable on their usage intention. Therefore, in testing the DOI variables it is necessary to define the target respondents narrowly. More future research is needed to confirm the DOI variable’s effects when the target respondents are narrowly defined.

5.3 Limitations of Study

The data collection process was challenging during the Covid-19 epidemic. To reduce the spread of the viral infection, precautions were taken. Due to the necessity to maintain social distance from others, it was challenging to implement the distribution of hard-copy surveys. Even though we have plenty of time to collect sufficient respondents, we also wasted time in sending our request to participating respondents to fill up the e-questionnaire and distributed the questionnaire QR code and URL link to their family members, peers, and friends. Although the snowball sampling technique allowed us to contact a sizable number of respondents, most of them were Chinese because they made up the bulk of the first-phase respondents. This sampling strategy produces biased samples because respondents with a large number of social connections can give investigators a larger proportion of additional respondents who have similar characteristics as the first respondent. Also, not all respondents will contact the current researcher for clarification.

Besides, the lack of past DOI studies and those related to AR is a limitation for use to gather enough information in building the current research model and comparison of data results. Past studies focused more on banking, insurance, and social marketing contexts. Therefore, it's not conducive for me to develop item statements that can measure specific variables in AR educational setting.

The non-support of studied DOI variables. For example, product features or outcomes that are compatible with respondents' living or social or economic education lifestyles are one of the determinants that influence buyers' purchasing and usage behavior. However, based on the result, the collected data is not sufficient for the authors to claim the important roles played by the compatibility variable. Therefore, the authors need to surf for information that can explain why respondents are behaving differently towards the effect of compatibility on intentional usage behavior.

5.4 Recommendation for Future Research

Future research should be more cautious in the survey questionnaire. Each sampling and distribution method has its own pro and cons factors. The pro is e-distribution and snowball method allows respondents to reach a larger count of respondents and those located far away from the researcher's study and permanent residents. The con is the demographic profile of participating respondents may be biased towards a specific group or category. Therefore, try to incorporate additional distribution methods like using the face-to-face method to overcome the biases problem and ensure the first batch of the participated respondents have a good spread of different demographic backgrounds. In order to ensure respondents are answering the questionnaire correctly, researchers can adopt video conferencing or use face-to-face method wherever feasible.

As AR technology is growing very well in Malaysia's entertainment, recreation, and shopping sectors (except the educational sector), more AR research should be carried out and use the DOI original and modified models as the basic theoretical framework. In this way, the pool of DOI and AR literature increases which is essential for future researchers' reference in developing their conceptual framework – research models and methodology.

The non-significant effect created by the DOI variable is not signifying that the DOI model is not a theoretical framework for reference. In fact, the non-significant effect is caused by inconsistent feedback given by target respondents. The follow-up checking shows that respondents with different demographic backgrounds such as education and living in residential areas could have different feedback in regards to the tested IV. For example, Gen-Z in rural areas may not be able to rationalize AR's beneficial outcomes in educational settings because AR is a perfectly new technology to them, as compared to Gen-Z residing in the city areas. Therefore, specific DOI predictors could create a non-significant effect for rural gen-z and a contrary effect for city gen-z. Future researchers, therefore, are recommended to define their target respondents more carefully so that proper implications for policymakers can be conveyed.

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Appendix 1

Table 3.2: Pilot Study Reliability Test Results

	Cronbach Alpha Score	No. of items
Relative Advantages (RA)	0.837	3
Compatibility (CB)	0.842	4
Complexity (CL)	0.858	4
Trialability (TB)	0.838	5
Observability (OB)	0.882	4
Perceived Value (PV)	0.904	5
Awareness (AW)	0.815	5
AR usage intention	0.709	3

Appendix 2

Section A: Demographic Section

Age: ☐ 10-15 ☐ 16-22 ☐ 23-27

Gender: ☐ Male ☐ Female

Race: ☐ Chinese ☐ Malay ☐ Indian ☐ Other

Current residential location:

☐ Wilayah Persekutuan ☐ Selangor
☐ Perak ☐ Penang
☐ Perlis ☐ Kelantan
☐ Kedah ☐ Terengganu
☐ Negeri Sembilan ☐ Melaka
☐ Pahang ☐ Johor
☐ Sarawak ☐ Sabah

Phone number ☐

Questionnaire

		1	2	3	4	5
	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Relative Advantage (RA)						
RA1	Augmented Reality (AR) education apps provide good experiential learning value.					
RA2	Augmented Reality (AR) education apps provide novel (or innovative or unique) experiential benefits in learning experiences.					
RA3	Augmented Reality (AR) education apps can change users' learning behaviors.					
Compatibility (CB)						
CB1	The use of Augmented Reality (AR) education apps is easier to adapt with the current delivery methods used by education service providers.					
CB2	The use of Augmented Reality (AR) education apps is easier to adapt with my current learning situation.					
CB3	Using an Augmented Reality (AR) education app fits well with the way I like to learn.					

CB4	Using an Augmented Reality (AR) education app fits into my learning style.					
Complexity (CL)						
CL1	I think it is difficult to use the Augmented Reality education apps.					
CL2	I think a number of task/ administrative procedures need to be performed when using the Augmented Reality education apps.					
CL3	I think it is difficult for me to remember how to perform the required tasks when using the Augmented Reality education apps.					
CL4	Using an Augmented Reality education app can be frustrating.					
Trialability (TB)						
TB1	I should be given the opportunity to try different Augmented Reality education applications.					
TB2	The providers of Augmented Reality education apps should give me sufficient time period in experiencing the different uses of the education apps.					
TB3	The providers of Augmented Reality education apps should assist me in test running the applications.					
TB4	I need to have a proper try out session before deciding whether to use the Augmented Reality education apps.					
TB5	The providers of Augmented Reality education apps should give me sufficient trial time period so that I can see what the apps could do.					
Observability (OB)						
OB1	I should be able to view the outcomes or consequences clearly upon using the Augmented Reality education apps.					
OB2	I believe I could communicate to others the outcomes or consequences of using Augmented Reality education apps.					
OB3	I think I won't have the difficulty telling others about the result of using Augmented Reality education apps.					
OB4	I think I won't have the difficulty in explaining whether it is beneficial or not beneficial to use Augmented Reality education apps.					
Perceived Value (PV)						
PV1	The Augmented Reality education apps provide good value to users.					
PV2	The Augmented Reality education apps improve users' learning ability.					
PV3	The Augmented Reality education apps increase users' esteem in performing specific work.					
PV4	The Augmented Reality education apps increase the profile or representation of the user's.					
PV5	Having Augmented Reality education apps is a status symbol in my organization.					
Awareness (AW)						
AW1	I am aware people are using the Augmented Reality education apps.					
AW2	I have seen the use of Augmented Reality education apps outside my education institution.					
AW3	It is easy for me to observe how others use the Augmented Reality education apps in my school.					
AW4	I am aware that Augmented Reality education apps can be used as teaching aids.					
AW5	I know that Augmented Reality education apps can be applied in various fields like research.					
Intention to use Augmented Reality (INT)						

INT1	I would like to experience the usage of Augmented Reality Apps in my education institution.					
INT2	I intend to use Augmented Reality Apps for learning					
INT3	I will recommend to the gen-Z to use Augmented Reality Apps for learning.					