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Adoption drivers of Augmented Reality: A fit-viability perspective

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Abstract— This paper aims to study the drivers of the adoption of Augmented reality via a fit-viable perspective in two dimensions. First, to develop and extend the FVM model to examine managers' intention to adopt AR. And the second fold will evaluate the model and access factors within organizations leading to augmented reality (AR) adoption. The framework of a fit-viability model was applied to determine the intentions of the organization's management to adopt Augmented reality for business growth. Based on the multiple theory the research is built on, the research aims to develop a set of instrumental measurements to examine the possibility of adopting AR technology. This study investigated four companies through interviews; three were ready to get on board with adopting AR technology. The results show empirical support for the FVM in assessing the adoption of new technology. Several theoretical and practical implications are derived from this study to indicate that managers must consider the relationship between new technology and the task requirement of the organization before adopting new technology. Management in many organizations can use this research to measure the possibility and viability of implementing AR technology to increase growth. This research is one of the first to combine the fit and viability models to understand what drives the adoption of AR technology.

Index Terms— Augmented reality, Fit-viability model, AR adoption, AR technology.

1 INTRODUCTION

Information systems have become an integral part of today's society. Adequate information must be available to understand the classic interaction between people, processes, and information systems. Over the years, much effort has been introduced to improve and develop unique technologies that have the potential to trigger a person's senses to a high level, resulting in a deep immersion in a partial or entirely virtual environment.

One famous technology employed to accomplish this virtual perception is augmented Reality (AR). Boeing researcher Tom Caudell coined augmented reality in 1990, while Louis Rosenberg created the first fully immersive AR system at the U.S Air Force Research Laboratory (Steur, 1992).

Augmented reality has received tremendous attention across many industries, from a science-fiction perspective to a science-based reality concept to a science-based reality concept. While the popularity and adoption continue to increase, how organizations may adopt AR technology to support unique business processes and what drives the adoption of AR have gone largely unexplored.

Adopting emerging technologies in the management information systems (MIS) area is marred with imminent unpredictability. Hence, several challenges impact the managerial decisions of organizations on adopting new technologies. IT adoption may be impacted by the benefit and intrinsic payoff to the firm. Economic agents such as the "network" value when competitors adopt the same technology can impact management decisions (Chulkov, 2017). Augmented Reality (AR) is an emerging technology that promises to transform how companies interact with their consumers and their environment. AR has gained a strong footprint in retailing and e-commerce because it enables consumers to create unique digital experiences that combine the physical and digital space (Verhagen, Vonkeman,
Feldberg, & Verhagen, 2014; Liang et al., 2007), heightening user engagements.

Moreover, while it has witnessed growing exploration of the potential by marketers and retailers, the lack of adequate knowledge and framework to measure what drives the adoption of AR by consumers and brands creates a stampede for large-scale investments in AR (BCG, 2018).

Augmented reality has been applied to consumer-oriented areas, and most mobile applications deliver an immersive experience. Although, large-scale applications of AR are still scarce in the business world as companies are in the process of understanding the economic importance of adopting AR in the business landscape (Arnaldi et al 2018). Even though there is a general understanding of how AR can impact business, very few engagements explore adopting AR technology to enhance business processes; adopting AR technology may double impact business operations. The first is enhancing engagement and immersion among employees,customers, ad suppliers using AR to improve business operations. The second is to invigorate ad scale business processes via AR capabilities to enhance organizational productivity and profitability.

1.2 Statement of Problem

Under the information system discipline, several notable theoretical and practical experiments are designed to analyze motives to adopt new innovative technology. Venkatesh et al. (2003) and Roy (2017) have been able to identify several conceptual models and frameworks that assess the intention to adopt new technology, such as the technology acceptance model (TAM) and the unified theory of acceptance and use of technology (UTAUT). Also, Kuan & Chau (2001) have discussed how technologies align within the firm, and its environment through the technology-organization-environment model (TOE), as well as Wu & Chen (2017) and Vallejo (2008), have richly elaborated on the task-technology fit (TTF). The problem with previous adoption frameworks is that the context is focused on how technology, organization, and environment interact. However,

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we must consider how these three factors, task requirement, organization readiness, and IT infrastructure, affect new technology adoption. Because of the lack of adequate research in understanding AR adoption, it is difficult to accurately interpret the varying effect of these factors as they affect managerial decisions when adopting new IT. There is a need to identify and introduce these factors from a managerial perspective to conceptualize a framework for adopting AR from a strategic viewpoint.

1.3 Significance of the Study

This study seeks to demystify the managerial standpoint through a framework that will improve the firm's value when adopting new technology. Therefore, providing meaningful insights to scholars, firms, and consumers of AR. The factors that affect managerial decisions need to be further examined through a Fit-viability model (FVM) that simplifies the complexities of technology adoption.

1.4 Purpose of the Study

Previous studies by Liang and Wei (2004) suggested an (FVM) that aligns the theory of TTF with the organizational viability of IT. They proposed a two-dimensional matrix that merged Fit and viability as its framework and was utilized to assess the intentions to adopt new technologies. The multi-dimension of the Fit-viability model shall express the purpose of this research in two folds. First, to develop and extend the FVM model to examine the manager's intention to adopt AR. Moreover, the second fold will evaluate the model and access factors within organizations leading to augmented reality (AR) adoption.

2 Research Framework and Methodology

Figure 1 illustrates the research framework as discussed in the FVM section above. This research aims to measure the adoption of AR technology. The framework follows the two dimensions of task and technology of the fit dimension; and the economic benefits, IT infrastructure, and organizational environment of the viability dimension. To measure Fit, the framework matches the characteristics of the task and technology.

Firm	A	B	C	D
Industry	Education	Telecommunication	Engineering & Manufacturing	Gaming & Entertainment
Founded	2010	2001	2015	2009
Total number of employees	50-100	50-100	50-100	5-10

In contrast, Viability evaluates the project's economic,

Three factors form the viability dimensions: IT infrastructure, economic, and organizational readiness for the technology. Sub-factors like asset specificity, uncertainty, and usage frequency form the criteria under the economic function of the viability dimension. Other functions like IT infrastructure are measured by the maturity of the software application and hardware performance and portability, AR presentation, and technical competence of IT staff. The main goal is to ensure top management support for the adoption of AR. Factors that promote adoption are encapsulated under the organizational factors, including employee and top management support, consumer support, and business process re-engineering.

Business process re-engineering is vital as top executives consider maintenance, technology upgrades, and usage.

Other factors needing consideration are user satisfaction and system usability, forming AR technology's performance. The research uses the Likert scale of 1-strongly disagree and 7-strongly agree to measure and analyze every instrument (Allen et al., 2007). Find the sample instrument in the appendix section. This project is exploratory research using a multi-case approach of the FVM to illustrate the adoption of AR technology. The following activities form the steps of this project:

- A research framework and scope
- Designing research instruments
- Identifying sample companies and key contact persons
- Data collection
- Data analysis, results, and conclusion.

This project identified four companies with relevant information after a thorough search. The companies range from different industries; An Education center, a telecommunications firm, an engineering and manufacturing firm, and a gaming and entertainment company. The dataset interviewed key officers in the firm, such as information officers, top executives, and managers. The research interviewed only four officers per company. Table 1 presents their background information.

TABLE 1
BRIEF SUMMARY OF THE FIRMS

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3 Research Findings, Results, and Discussion

This section discusses the key research findings from the sample data set collected across the industries. Our study is the first attempt to deploy the Fit-viability model to measure the adoption of AR technology in organizations.

Firm A. Firm A is an education center. Their core objective is to provide quality education services to teenagers and children. They use computing software to design graphic visuals during learning. Since firm A is currently doing a lot of graphic illustrations and classroom studio learning as their task characteristic, AR technology can align the task-technology fit of firm A. They started the business ten years ago and suggested they are not sure management will approve a full-scale AR adoption project. Customer desires change rapidly, same with environmental factors, which gives AR technology the edge to improve immersive learning among students. In economics, the research assessed firm A's feasibility as medium and a score of 4.75 out of a seven-point scale.

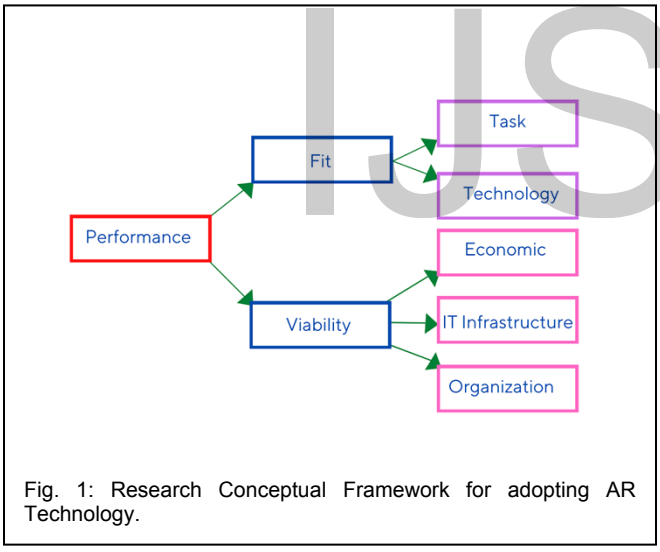

Fig. 1: Research Conceptual Framework for adopting AR Technology.

Firm A will require a custom-built Augmented reality application to complement their visualization tools regarding the IT infrastructure. They have a few experienced staff who can quickly manage the business re-engineering process. However, these factors scored the IT infrastructure an overall medium to high. Some top executives were ready to re-engineer their business processes by introducing AR technology. Therefore, for organizational readiness, the impact on business processes will be significant as firm A scored an average of 5.18 out of seven, a high target adoption. In this case, the average viability score is 5.12, and the Fit score is 5.15, high on both dimensions, resulting in a reasonable success.

Firm B. This telecommunications service provider is dedicated to providing digital services like cloud computing, internet services, and data management services to many companies and government organizations in Nigeria. These services require little visualization; hence top executives are not highly motivated to adopt AR to improve business processes. They use digital technologies like programming applications, computers, and mobile devices to perform business functions. Although some top executives are willing to explore the potential and possibility of AR in the digital business space, they are willing to provide the required budget to complete the project. Firm B scored a 4.65 out of seven in terms of economic feasibility, as financing the project might be a problem if it doesn't categorically align with the organization's needs.

The IT infrastructure has skilled IT staff and a proper data management system, resulting in a high score. The top executive supports adopting AR to optimize communication with clients, investors, and employees under training. They recognize AR technology's potential and have capable engineers and programmers to manage it. However, with a view of the current business processes, the technology does not adequately fit the task at hand; hence AR technology is not a good target for Firm B.

Firm C. An engineering and manufacturing company located in Akwa Ibom, Nigeria. They provide design, engineering, and manufacturing services to individuals, organizations, and government offices. They have yet to implement any virtual or Augmented reality technology into their business processes. Still, the top management is unwilling to adopt AR to improve productivity and customer satisfaction. Management is not willing to fund any AR adoption project as they can't fund such a project due to implementation costs, even though it is likely to improve the productivity and profitability of the company. Since Firm C is an engineering and manufacturing company, they want to virtualize business processes and monitor manufacturing equipment. Hence, AR technology is not good viability for the technology in firm C, resulting in an average overall score.

Regarding economic viability, the firm has existed for many years and has the financial capacity to implement the adoption of AR technology into its business processes. These factors led to a poor score out of seven. The firm is unwilling to outsource an AR vendor to develop applications for its business. Also, their workforce lacks the skilled IT staff required to manage and maintain the AR-powered application. This contributed to an average overall score.

Firm D. is a gaming & entertainment company with over three years of experience in the gaming industry. Firm D is the most exposed company as they Deliver VR gaming services to their clients but have yet to implement AR features. They are the most experienced and willing firms to adopt AR compared to other firms in this study. Firm D has competent IT staff to handle AR implementation and maintenance and adequate software and application experience. The top management is highly motivated to adopt AR and re-engineer its business processes. However, they are ready to implement the AR project as they consider it costly.

Regarding their line of business, introducing AR technology to the list of gaming and & entertainment possibilities will certainly

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improve their productivity and profitability. The technology is a strong fit for the task characteristics, resulting in a high score of 7. The economic viability, IT infrastructure, and organizational readiness under the viability dimension of this research scored 6.75, 5.82, and 6.01, respectively.

This research is exploratory, and it contributes immensely to the literature. Figure 4.1 illustrates the relative position of these firms on the FVM framework. All firms have a high fit for adopting AR technology. This indicates that most organizations are aware of the importance of adopting AR technology but may not properly assess its viability. Although a high fit dimension does not guarantee system success, if the two dimensions are properly accessed, there is a high possibility of success. After the analysis, firms A, B, and D fall in the category of a good target. Only Firm C needs to find an alternative technology with a lower project budget cost as AR adoption will be capital intensive.

TABLE 2
SUMMARY OF THE TOTAL SCORES OF THE FIRM IN THIS RESEARCH

Construct		Item	A	B	C	D
Fit	Task-technology fit		5.5	5.5	6.0	7.00
			4.8	4.335	6.5	7.00
Subtotal scores			5.15	4.917	6.25	7.00
Viability	Economic	Project budget	4.5	4.00	3.00	6.50
		Implementation cost	5	5.25	3.00	7.00
	Scores		4.75	4.65	3.00	6.75
	IT infrastructure	Software & Hardware	5	6.00	5.00	6.25
		Skilled IT staff	4.75	5.60	3.00	6.2
		Data management	6.5	6.50	7.00	5.00
	Scores		5.417	6.03	5.00	5.82
	Organization	Business process re-engineering	5	6.00	3.00	5.00
		User competence	5.17	5.5	3.00	6.30
		Top management support	5.37	6.125	2.70	6.75
	Scores		5.18	5.87	2.90	6.01
Subtotal Scores			5.12			
Total scores			5.13	5.37	4.285	6.395

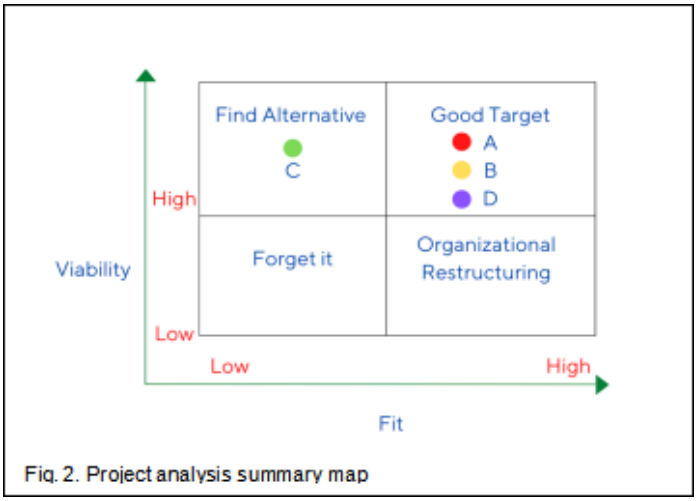

Fig. 2. Project analysis summary map

A major problem in firm C is that even though the top management does not support the adoption of AR technology and has limited skilled IT staff to manage it, management is not willing to implement a project on AR adoption.

They have no present need for a standard AR-powered system. They will have to find an alternative technology since they have high viability and low fit. Therefore, VM is beneficial in evaluating the adoption of AR technology. We can derive that AR technology's task characteristics and nature are vital for adopting AR technology. As illustrated in figure 4.1, all four companies have a high degree of Fit. This implies that companies with little or no use for AR technology will have a low possibility of surviving management review in selecting new technology. Organizational readiness contributes a key role in AR technology performance. Although firm A had low-organizational support, it didn't significantly impact the overall performance if they adopted AR. Ensuring that the task requirement and technology characteristics align is the most important factor when adopting new technology. Regardless of the engineering and manufacturing firm, all other firms had a better-aligned task-technology fit. Also, we could not establish a reliable instrument for measuring the degree of fit between technology capabilities and task requirements. Hopefully, future research will develop a better and more reliable instrument to assess the effect of different Fit levels on the system adoption of AR technology.

Our findings have bridged the literature gasp on adopting AR technology via a fit-viable perspective.

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TABLE3

AR TECHNOLOGY-RELATED LITERATURE FROM STRATEGIC SERVICE MARKETING THEMES

			AR variable(s)	Process variables	Boundary Conditions	Dependent variables	Key findings
Theme: Gaining customer acceptance of new service technologies							
Spreer and Kallweit (2014)	AR for book retail; field study	Technology acceptance model (TAM)	Usefulness, enjoyment, ease of use	-	-	Assessment of information offered, information completeness, intention to reuse	Consumers assess AR-enabled information more easily and wholly. The reuse of AR is driven by its overall usefulness and satisfaction.
Huang and Liao (2015)	Experiment using AR for online clothing retail	Technology acceptance model (TAM), experimental value.	Presence	Ease of use, usefulness, aesthetics, service excellence, playfulness	Cognitive innovativeness	Sustainable relationship behavior intentions	Presence foretells technology acceptance and experiential value variables. The outcome of behavioral intentions differs across levels of individual cognitive innovativeness.
Rese et al. (2016)	User feedback on AR applications: laboratory experiments	Technology acceptance model (TAM)	Informativeness, enjoyment, ease of use	Usefulness, attitude toward using	-	Intention to use	The TAM model anticipates the acceptance of AR applications.
Javornik (2016b)	User feedback on AR media characteristics: laboratory experiments	Media Characteristics	Interactivity, augmentation	Flow	-	Affective, cognitive, and behavioral responses	Flow conciliates augmentation's positive effect on consumers' affective, cognitive and behavioral responses.
	Theme: Enhancing customer service experiences in a multichannel environment	Novelty effbeliefs	Novelty	Attitude toward AR	Technological self-efficacy beliefs	Attitude toward brand	Novelty is a a contradiction of attitude towards AR. High Tech leaders could tarnish the brand with such an attitude.
Dacko (2017)		Mobile AR applications for percipient retail; survey					
Beck and Crié (2016)	AR virtual greenroom for on- and offline retail, online experiments	Experiential value	-	-	-	Experiential shopping benefits, behavioral intentions, perceived drawbacks.	AR is created to render more efficient and entertaining shopping experiences, complete information, and decision certainty, resulting in positive behavior. Privacy is still considered a drawback of AR.
Olsson et al. (2013)	AR services for shopping cen a	Intrinsic and extrinsic	-	Perpetual-specific	-	Purchase intention	AR use increases the possibility of users

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4 Conclusion

This paper seeks to present a framework for assessing companies' successful adoption of AR technology. The augmented reality remains a fascinating technology that can revolutionize how businesses operate across many industries if proper assessment and implementation strategies are done. Augmented Reality (AR) is an emerging technology that promises to transform how companies interact with their consumers and their environment. AR has gained strong footprints in retailing and e-commerce because it enables consumers to create special digital experiences that combine the aesthetic of the physical and digital space and heighten user engagement. This study uses the FVM research framework built on the seminal work of Liang and Wei (2004) to extend the task-technology fit model along two dimensions of Fit and Viability. Our findings indicate that Fit defines the requirements for measuring Fit and Viability in the FVM. The fit refers to the degree to which new technology can align with the core competence and suitability to perform required business processes in an organization. The fit dimension exposed the core relationship between the task needed for technology introduction and the IT needed to carry out that task within an organization.

Combining technology and task factors is important for organizations to remain productive and profitable. Viability measures the value-added potential of new technology, implementation cost, human intervention requirements, and the environment if the organization chooses to adopt the innovation.

The framework further broke down fit and Viability into more detailed items to measure AR technology's adoption. The research answers the one critical question, "Will businesses be able to adopt Augmented reality (AR) when they view the technology as a fit-viable option for organizational growth?" Absolutely yes. This model explains managers' intention to adopt AR technology organizations. It is important to know that top management support plays a vital role in adopting AR. Still, the one critical factor is ensuring the technology can solve the task requirements in the organization. And Viability perspective promotes the adoption of AR technology as this provides valuable insights to top management when making critical business decisions. The study investigated four companies through interviews, and three were ready to get on board with adopting AR technology. The results show empirical support for the FVM in assessing the adoption of new technology.

Several theoretical and practical implications are derived from this study to indicate that managers must consider the relationship between new technology and the task requirement of the organization before adopting new technology.

Finally, the degree to which the Fit-viability perspective can be generalized to other technologies is unclear. We are unaware of other environmental or industry factors affecting this model. However, this is an explanatory study and will need further research.

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