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USING SYSTEM DYNAMICS SIMULATION TO DEVELOP STRATEGIES TOWARDS IMMERSIVE TECHNOLOGY ADOPTION IN INDONESIA: A CASE OF PT. SUWIR TBK.

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Abstrak

PT. SUWIR adalah salah satu dari sedikit perusahaan Indonesia yang menjual solusi teknologi imersif. Kondisi tingkat penetrasi ini menjadi peluang bagi PT. SUWIR untuk memperkenalkan teknologi tersebut di Indonesia dan merebut pasar. Penelitian ini bertujuan untuk melihat variabel apa saja yang mempengaruhi tingkat adopsi teknologi imersif di Indonesia, dan strategi apa yang terbaik untuk PT. SUWIR untuk memaksimalkan pengadopsian produk dan layanan mereka di Indonesia. Penelitian dilakukan dengan melakukan tinjauan literatur untuk mengambil variabel penting dari adopsi teknologi, mengidentifikasi hubungan antar variabel dan membuat model sistem dinamik dari hubungan tersebut, memvalidasi model dengan mengkalibrasi dengan data riil perusahaan, membuat skenario strategi yang berbeda-beda, mensimulasikan skenario tersebut dan menganalisis hasilnya, lalu diakhiri dengan membuat rekomendasi strategi berdasarkan hasil simulasi. Variabel yang diturunkan dari Technology Acceptance Model (TAM) adalah Perceived Usefulness dan Perceived Risk, dengan Perceived Usefulness dipengaruhi oleh variabel self-efficacy, quality, dan ease of use. Dua variabel Perceived ini berhubungan dengan Intention to use. Intention to use dikaitkan dengan variabel yang diturunkan dari model Bass Diffusion, yaitu Potential Adopters From Promotional Activities dan Potential Adopters From Word-of-Mouth Activities, yang akan berhubungan dengan tingkat adopsi produk dari Calon Adopter menjadi Adopter. Model divalidasi dengan membandingkan jumlah Adopters hasil simulasi dengan jumlah pengguna pada layanan platform yang dikembangkan oleh PT. SUWIR. Hasil penelitian berdasarkan pengujian skenario menunjukkan bahwa strategi terbaik untuk memasarkan produk adalah dengan lebih fokus pada kegiatan dari mulut ke mulut karena memiliki dampak yang lebih besar pada adopsi produk daripada kegiatan promosi.

Kata Kunci: Sistem Dinamik, Teknologi Imersif, Difusi, Penerimaan Teknologi

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Abstract

PT. SUWIR is one of the few Indonesian companies selling immersive technology solutions. This penetration level condition is an opportunity for PT. SUWIR to introduce this technology in Indonesia and seize the market. This study aims to see what variables influence the level of adoption of immersive technology in Indonesia, and what is the best strategy for PT. SUWIR to maximize the adoption of their products and services in Indonesia. The research was carried out by conducting a literature review to take important variables from technology adoption, identify relationships between variables and create a dynamic system model of these relationships, validate the model by calibrating with real company data, create different strategy scenarios, simulate these scenarios and analyze the results. , then ends by making strategic recommendations based on the simulation results. The variables derived from the Technology Acceptance Model (TAM) are Perceived Usefulness and Perceived Risk, where Perceived Usefulness is influenced by the variables self-efficacy, quality, and ease of use. These two Perceived variables relate to Intention to use. Intention to use is associated with variables derived from the Bass Diffusion model, namely Potential Adopters From Promotional Activities and Potential Adopters From Word-of-Mouth Activities, which will relate to the level of product adoption from Prospective Adopters to Adopters. The model is validated by comparing the number of Adopters from the simulation results with the number of users on the service platform developed by PT. SUWIR. The results of the research based on scenario testing show that the best strategy for marketing a product is to focus more on word of mouth because it has a greater impact on product adoption than promotional activities.

Keywords: *System Dynamics, Immersive technology, Diffusion, Technology Acceptance*

Introduction

COVID-19 pandemic has undoubtedly changed the behavior and lives of many people around the world. Policy of social distancing requires people of all ages to look into digital technology as a solution, A survey shows that COVID-19 has accelerated the consumer technology adoption by 3-4 years, and this behavior change is predicted to last long-term into the future (McKinsey, 2020). Among the increased technology adoption were immersive technologies including Augmented Reality (AR) and Virtual Reality (VR) (Ball et al., 2021).

Global immersive technology market size is expected to grow at a CAGR of ~24% with expected 1.2 trillion market size in 2035, and patents of immersive technology products has grown by 200% from 2018 to 2021 (ABI Research, 2021). Immersive technology use cases are initially entertainment-based, such as gaming with Pokemon Go (Qin, 2021), but the more recent use cases such as increasing user experience in tourism (Fan et al., 2022), education through arts, science, and history museums (Zhou et al., 2022), automotive (Firu et al., 2021), and health sector in surgery (Jean, 2022).

Technological advancements also happen in the form of online shopping through e-commerce (Higueras-Castillo et al., 2023). Although comfortable, customers are not able to inspect product quality when online shopping. A significant barrier to the internet market is the product ambiguity brought on by the physical distance between consumers and products, which inhibits demand and causes buying hesitancy. To lessen consumers' concern, internet shops have been working continuously to offer third-party assurances, online reviews, and multimedia information. The listed tactics, however, primarily aim to lower buyers' skepticism over the caliber of the products.

Uncertainty among consumers over how well a product fits their tastes is still a problem. (Sun et al., 2022). This is the gap that immersive technologies can fill, allowing virtual interaction between the customer and the product, examples include trying on clothes or beauty products for the decision-making process. Several large companies are investing in VR shopping applications. China’s e-commerce giant Alibaba, the U.S. department store Macy’s, the Swedish car manufacturer Volvo, the French hypermarket Carrefour, travel giant Marriott International, as well as Europe’s largest retailer for consumer electronics (SATURN) recently launched VR shopping applications.

The "Ikea Place" smartphone app was created by IKEA using Apple's ARKit technology. Customers can choose a virtual image of a piece of furniture from this smartphone software and then position it in their houses by concentrating on a certain region on their phone screens. In other words, a smartphone camera scans a user's house, imagines the furniture in it, and creates an overlaid overlay by superimposing an image of the chosen furniture onto a virtual representation of the user's house. Thus, a virtual "view" of the customers' homes is displayed on the smartphone screen, giving the impression that the customers have actually placed the chosen furniture in their homes. Customers may visually see how the furniture would look on their cellphones in this way without really buying and putting the furniture into their homes. (Park et al., 2020).

In Indonesia, there are currently not a lot of companies focusing on this market, especially companies listed in the Indonesian Stock Exchange. This serves as an opportunity for SUWIR to be the market leader. However, as of now the user penetration of AR and VR in Indonesia is very low, around 32% in 2023 (Statista, 2022). Increasing this rate is necessary to further increase the potential customer and eventually the potential revenue of PT. SUWIR.

The research questions are as follows: (1) What are the variables that influence the adoption of immersive technology products and services in Indonesia?, (2) What is the recommended strategy to maximize the adoption of immersive technology products and services of PT. SUWIR in Indonesia?

This research aims to analyze the variables impacting the adoption rate of immersive technology products and services, and design marketing plans for PT. SUWIR for its market penetration

Chapter 2 will discuss relevant literature on Bass diffusion, immersive technology, technology acceptance models, system dynamics, and justification on adding additional variables. Chapter 3 will discuss methods and steps used in this research. Chapter 4 will

discuss the proposed solution and implementation plan. Chapter 5 concludes the research with a summary and further research opportunities.

Research Method

A research design is a blueprint or plan for the collection, measurement, and analysis of data to answer the research question. The research design for this research is a combination of qualitative and quantitative research. The data collection will be qualitative, and the data analysis and validation will be quantitative. The steps are as below.

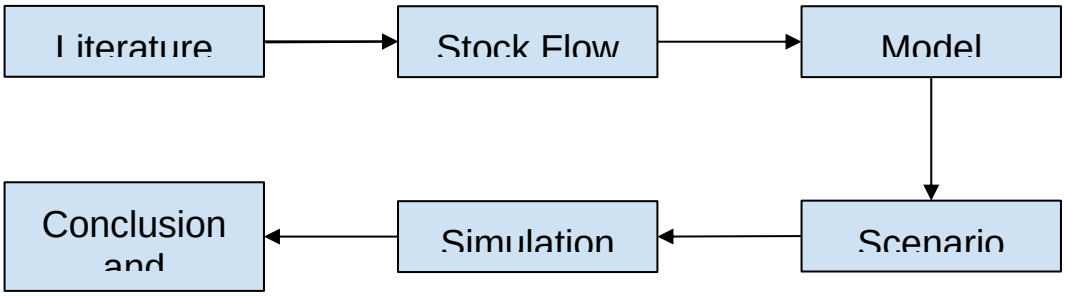

Figure 1. Research Design

The primary data collection method used in this research is using literature review and interviews. A literature review is a process of understanding previously published research related to the topic. The literature review aims to collect the key variables related to technology adoption, collect initial values and formulate equations for the parameters. The data analysis method in this research is using System Dynamics modeling. System dynamics is suitable for this research because the output model can be modified easily and tested in multiple scenarios to better understand the best alternative to the problem. The model and the variables are then validated by expert opinion by the related employee of PT. SUWIR

Result and Discussion

A. Analysis

1. Key Variables

Based on the literature review, the variables affecting the adoption of AR and VR products are as follows.

Table 1
Variable List for the System Dynamics model

Parameter	Description	Type	Unit	Formula	Source
Self-Efficacy Value	The level that a person believes he/she can use the technology	Constant	Dmnl	= 0.3	Adopted from (Bastan et al., 2020)

Self-Efficacy Factor	Contribution fraction of self-efficacy	Constant	Dmnl	= 0.1	Adopted from (Bastan et al., 2020)
Quality Value	The level that a technology brings good value	Constant	Dmnl	= 0.2	Adopted from (Bastan et al., 2020)
Quality Factor	Contribution fraction of quality	Constant	Dmnl	= 0.3	Adopted from (Bastan et al., 2020)
Ease of Use Factor	Contribution fraction of ease of use	Constant	Dmnl	= 0.6	Adopted from (Bastan et al., 2020)
Ease of Use Value	The level that a technology is looked at as easy to use	Constant	Dmnl	= 0.1	Adopted from (Bastan et al., 2020)
Perceived Usefulness Value	The level that a technology is able to be used as expected	Auxiliary	Dmnl	= Perceived Ease Of Use Factor*Perceived Ease Of Use Value+Quality Factor*Quality Value+"Self-efficacy Factor"*"Self-Efficacy Value"	Adopted from (Bastan et al., 2020)
Perceived Usefulness Factor	Contribution fraction of perceived usefulness	Constant	Dmnl	= 0.6	Adopted from (Bastan et al., 2020)
Perceived	The level of	Constant	Dmnl	= 0.1	Adopted

Risk Value	uncertainty to the future related to a technology				from (Bastan et al., 2020)
Perceived Risk Factor	Contribution fraction of perceived risk	Constant	Dmnl	= 0.4	Adopted from (Bastan et al., 2020)
Intention To Use	The level that a potential customer has planned to use a technology	Auxiliary	Dmnl	= Perceived Risk Factor*Perceived Risk Value+Perceived Usefulness Factor*Perceived Usefulness Value	Adopted from (Bastan et al., 2020)
Advertisement Effectiveness	The level of effectiveness of marketing activities of a company by advertisement	Constant	Dmnl	= 0.05	Adopted from (Horvat, 2020)
Word-Of-Mouth Effectiveness	The level of effectiveness of marketing activities of a company by word of mouth	Constant	Dmnl	= 0.05	Adopted from (Horvat, 2020)
Total Population	Total target market size of the technology	Constant	People	= 10 million	Assumption
Contact Rate	Number of contacts between	Constant	1/Year	= 60	Expert Opinion

	potential adopters and adopters per person per year				
Number of Contacts	Number of total contacts between potential adopters and adopters per year	Auxiliary	People/Year	= Contact Rate * Adopters	Expert Opinion
Potential Adopters from Promotional Activities	Number of people likely to use a technology as a result of promotional activities	Auxiliary	People/Year	= Advertisement Effectiveness * Intention to use * Potential Adopters	Adopted from (Horvat, 2020)
Potential Adopters from Word-Of-Mouth Activities	Number of people likely to use a technology as a result of word of mouth activities	Auxiliary	People/Year	= (Word of mouth effectiveness * Intention to use * Number of contacts * Potential adopters) / Total population	Adopted from (Horvat, 2020)
Potential Adopters	Number of people who are likely to use a technology	Stock	People	= INTEG(-Adoption Rate)	Adopted from (Horvat, 2020)
Adopters	Number of people who uses a technology	Stock	People	= INTEG(Adoption Rate)	Adopted from (Horvat, 2020)

Adoption Rate	Number of people likely to adopt a product per year	Flow	People/Year	= Potential Adopters from Promotional Activities + Potential Adopters from Word-Of-Mouth Activities	Adopted from (Horvat, 2020)

2. Stock Flow Diagram (SFD)

The Stock and Flow Diagram is as below. The variables of Perceived Usefulness, Perceived Risk, and Intention To Use are derived from the Technology Acceptance Model, with Intention To Use representing the personal self barrier to adopt technology. This barrier contributes to the number of potential adopters from promotional activities, along with the constant of advertisement effectiveness and the value of potential adopters. The barrier also contributes to the number of potential adopters from word-of-mouth activities along with the number of potential adopters, adopters, total population, word-of-mouth effectiveness, and number of contacts between non-adopters and adopters.

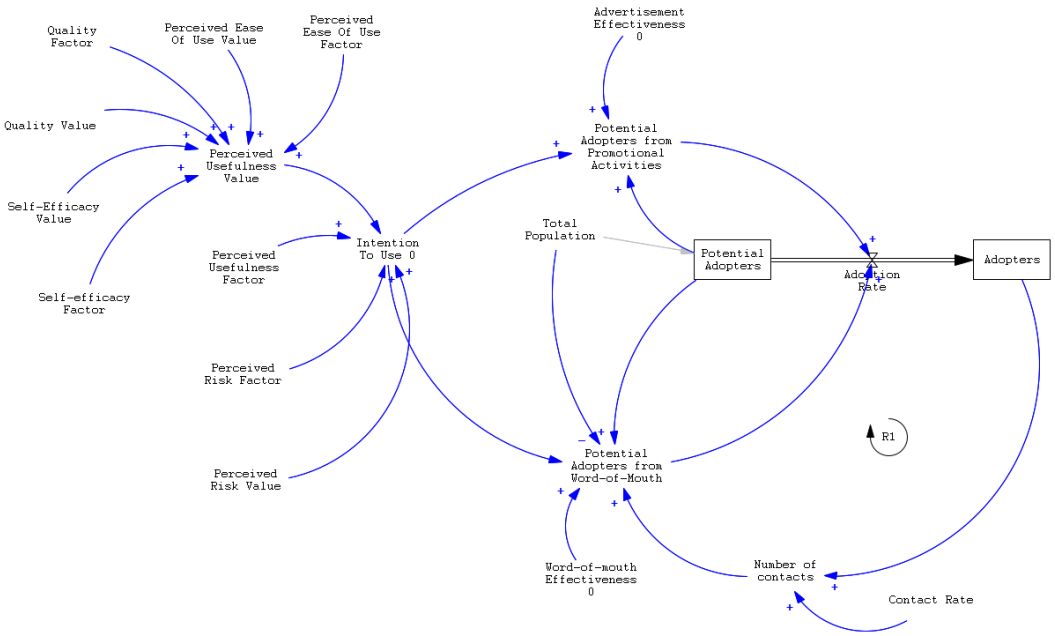

Figure 2. Proposed Stock and Flow Diagram

3. Model Validation

Model validation is done to make sure the model closely represents the actual system behavior. A validated model can further be used to forecast system behavior into the future and decision makers in the company can react accordingly.

The first basic step of model validation is by model checking and unit checking. These are to check the consistency and errors of the created model and the units. These checks are available in Vensim. The result indicates that the proposed model has no errors and is consistent.

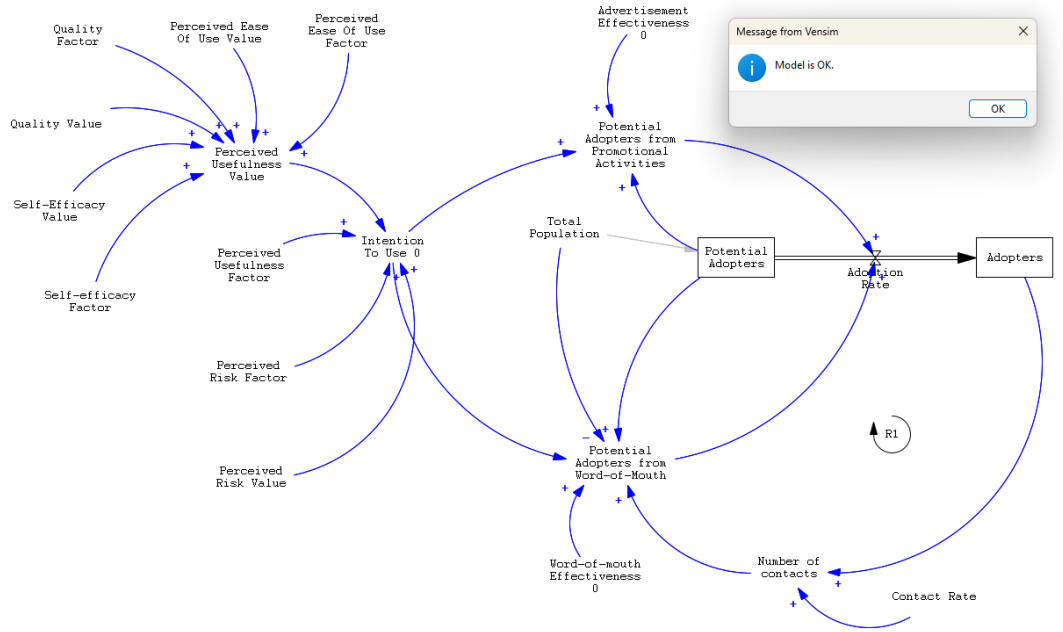

Figure 3. Model Check

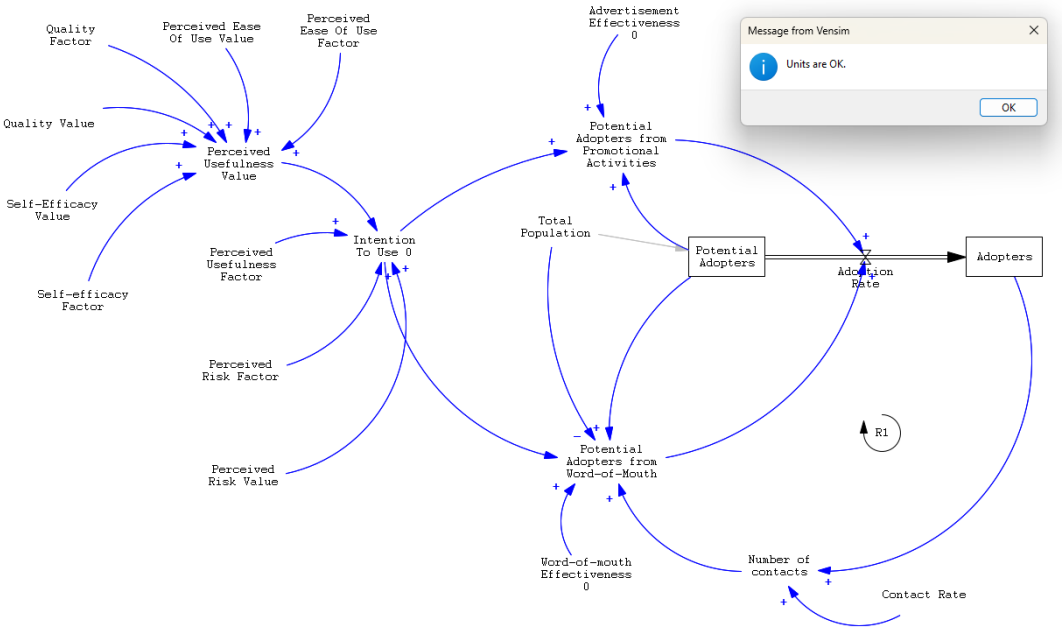

Figure 4. Unit Check

The model is validated with the number of users of platform services of PT. SUWIR for year 2020-2022

Table 2
Number of yearly users of platform services of PT. SUWIR

Year	2020	2021	2022
Users (in thousands)	16	25.5	55

When the model is simulated, the simulation result (in blue) shows a similar pattern to the reference historical data of users (reference mode in red), meaning the model is valid.

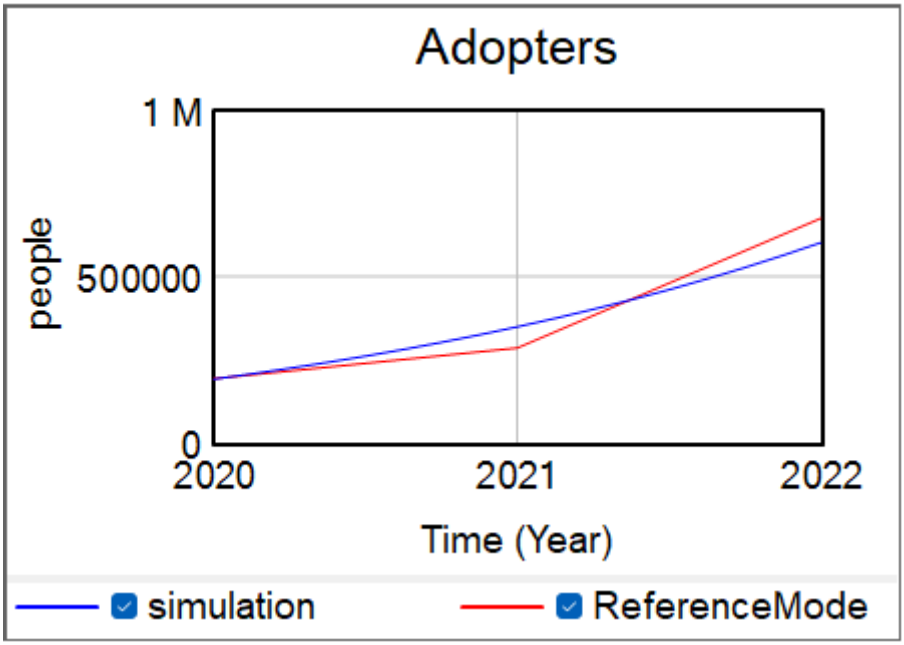

Figure 5. Model simulation test compared to historical data

4. Scenario Development

From the created model, different scenarios are created by changing the variables in the model to look at the simulation result from the scenarios. These scenarios can then be used to develop optimal strategy to achieve the desired result. In this research, the developed scenarios are as follows.

a. Increasing Word-of-Mouth effectiveness
b. Increasing Promotional/advertisement effectiveness
c. Increasing Perceived Risk Value
d. Increasing Perceived Usefulness Value by Self-efficacy
e. Increasing Perceived Usefulness Value by Quality
f. Increasing Perceived Usefulness Value by Ease Of Use

Scenario 1 and 2 aim to look at what type of marketing activities is best to maximize immersive technology adoption, while the other scenarios aim to look at

what variable gives the most impact in a person's internal barrier to adop immersive technology products.

5. Simulation and Analysis

Each scenario is simulated and compared to current data and the result is analyzed to develop the optimal marketing strategy. The simulation is run in Vensim software and the simulation time is set to start from 2020 to 2030. The observed variable is Adoption Rate and Adopters. First, we take a look at the baseline simulation result with the closest representative to the actual data when the simulation is extended to the year 2030.

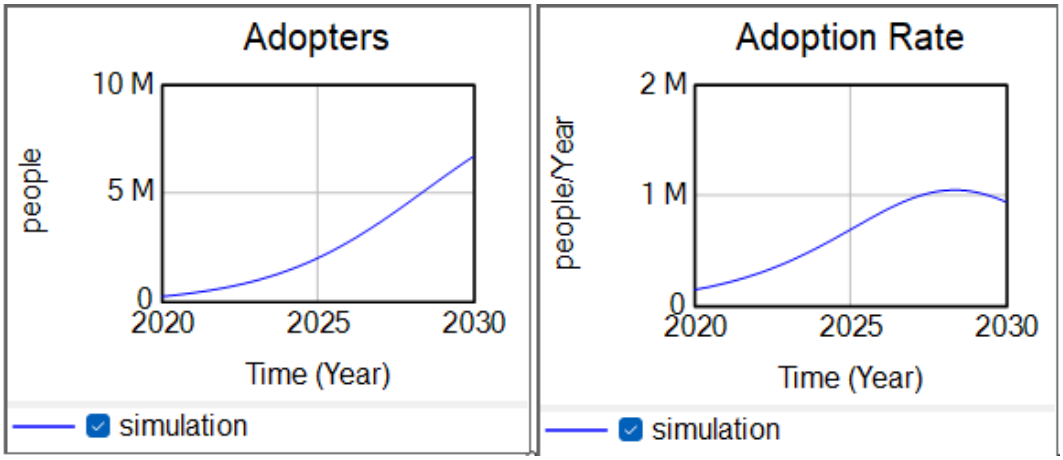

Figure 6. Baseline model simulation test to year 2030

Based on the simulation above, by the end of 2030, the number of adopters will be around 6.5 million people. With an assumed total target market of 10 million people, at the current state, it will take longer than the year 2030 to capture the target market. Furthermore, from the graph above, the adoption rate is seen to increase until it reaches its peak at year 2028 with approximately 1 million adopters per year, and then the adoption rate decreases from year 2028 beyond.

The result of simulation for scenario of increasing word-of-mouth effectiveness to 0.2 (Scenario 1), 0.4 (Scenario 2), and 0.75 (Scenario 3) is as below.

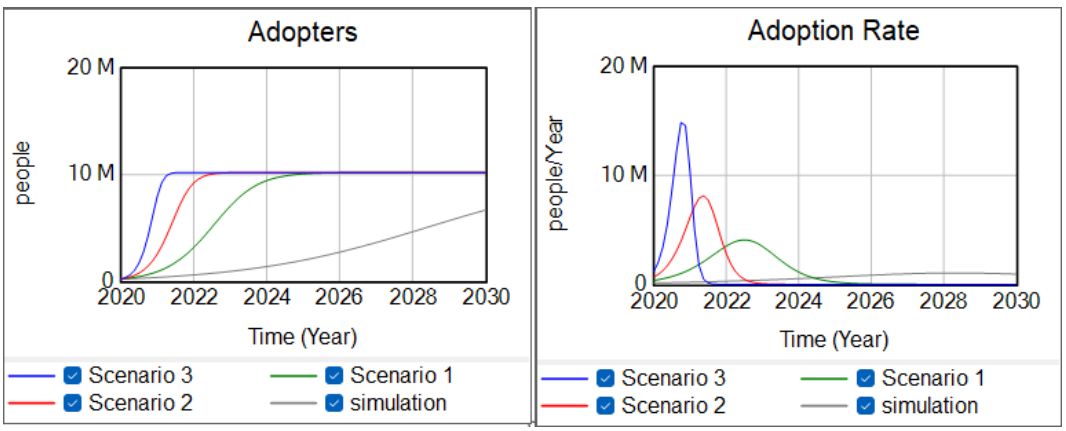

Figure 7. Scenario simulation of increasing WoM effectiveness

The simulation shows that increasing word-of-mouth effectiveness will fasten the adoption rate and decrease the time taken to capture the target market. The adopters will reach maximum by 2025 (Scenario 1, green), 2023 (Scenario 2, red), and 2021 (scenario 3, blue).

The result of simulation for scenario of increasing promotional effectiveness to 0.2 (Scenario 1), 0.4 (Scenario 2), and 0.75 (Scenario 3) is as below.

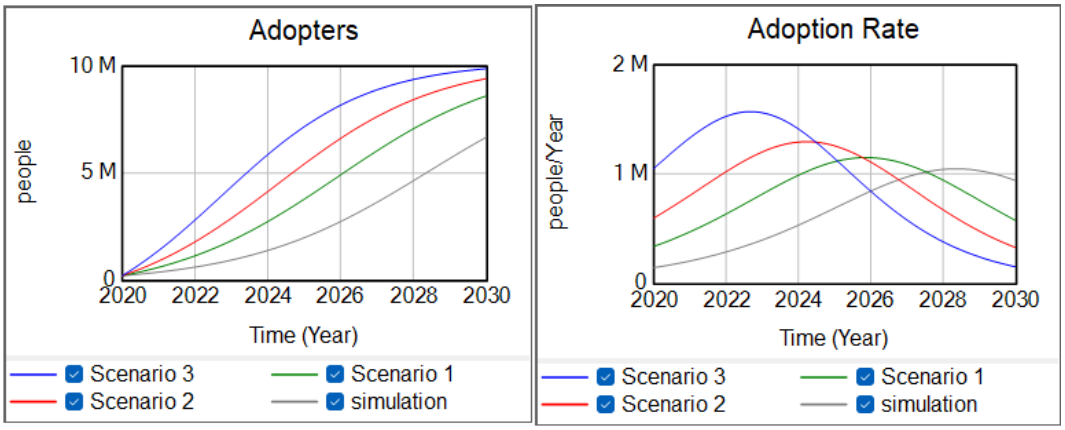

Figure 8. Scenario simulation of increasing promotional effectiveness

From the simulation, it can be seen that the increase in adoption rate is not as much as the previous scenario. This is because there is no feedback loop that increases the potential adopters from promotional activities, unlike potential adopters from word-of-mouth activities that increase over time as the number of adopters increase. With this method, the whole target market can only be reached when the promotional effectiveness increases to 0.75 or above.

The result of simulation for increasing perceived risk value and perceived usefulness value to 1 is as below.

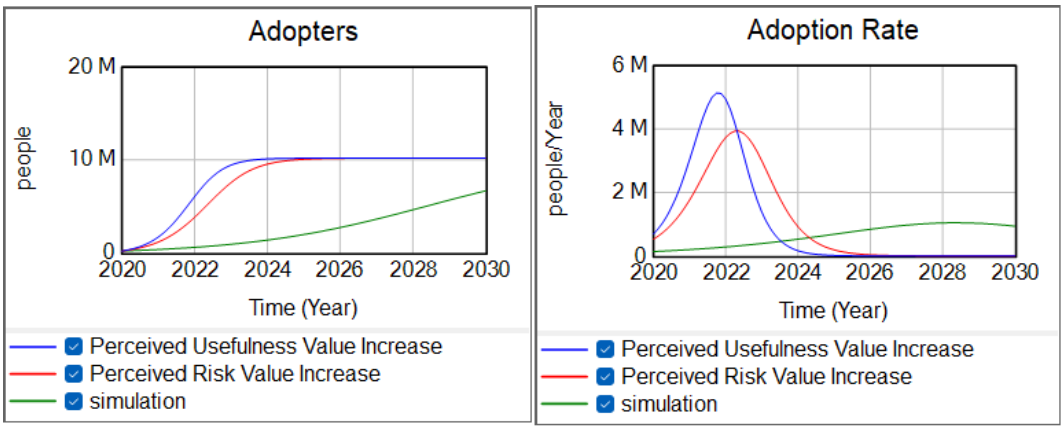

Figure 9. Scenario simulation of maximizing perceived usefulness value and perceived risk value

From the simulation, it can be seen that increasing perceived usefulness gives better results than increasing perceived risk, although the difference is not much. The result of simulation for increasing variables related to perceived usefulness value is as below.

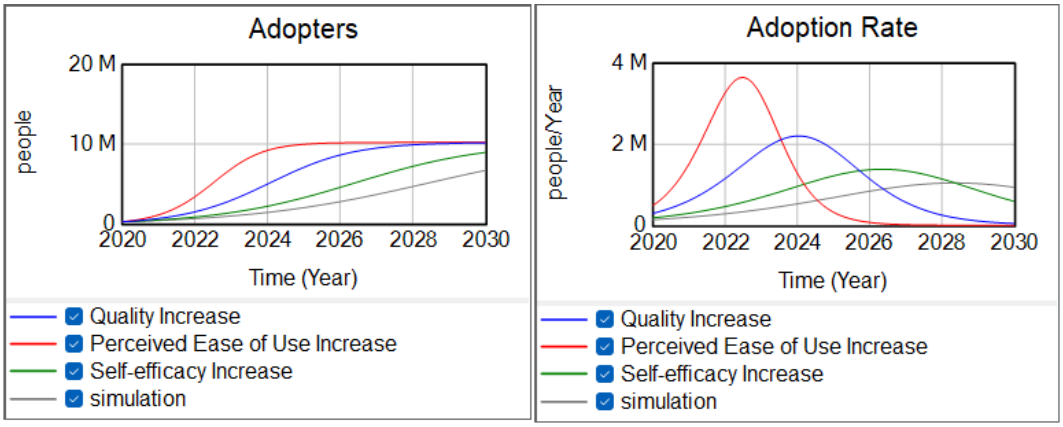

Figure 10. Scenario simulation of maximizing perceived ease of use value and quality value and self-efficacy value

From the simulation results, it can be seen that perceived ease of use has the greatest impact compared to other variables on increasing adoption rate. The last scenario is simulating the ideal scenario of maximum effectiveness on word-of-mouth and promotional activities. The result is as below

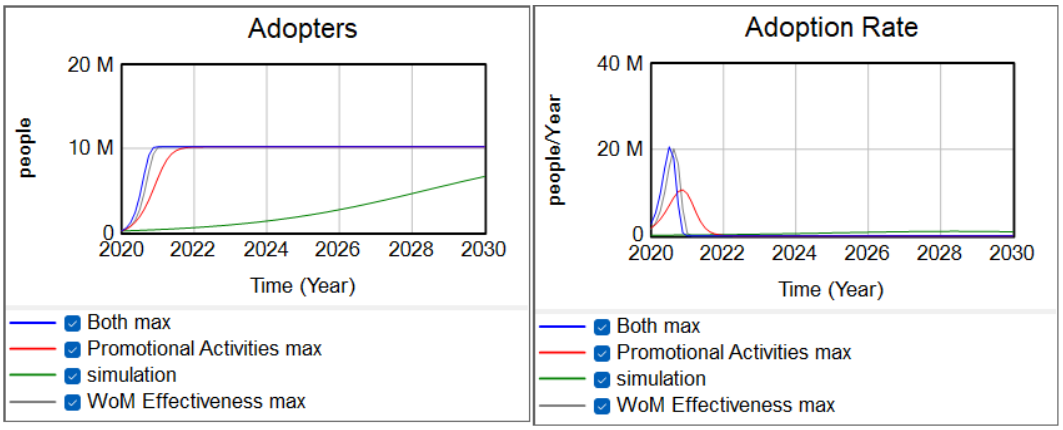

Figure 11. Scenario simulation of maximizing both promotional effectiveness and WoM effectiveness

From the simulation results, it can be seen that both maximum effectiveness of word-of-mouth and promotional activities give the best result, although the result is not so far from the scenario maximum WoM effectiveness.

Based on all the results, the best adoption rate is given by increasing both promotional and word-of-mouth marketing, with more focus on word-of-mouth.

The promotional activities are more effective if they emphasize the product's usefulness with more focus on ease of use.

6. **Business Solution**

The proposed system dynamics model shows how the promotional activities and the word-of-mouth activities affect the adoption of immersive technologies in Indonesia. Therefore, when possible, given the sufficient resources, PT. SUWIR should focus on enhancing the effectiveness of promotional and word-of-mouth. More specifically, these activities should be able to increase potential customers' intention to use the product and decrease barriers towards using the product, which consists of perceived usefulness and perceived risk.

7. **Implementation Plan & Justification**

The implementation plan should start with introduction of the model to every team involved, including the marketing team, design team, and engineering team. This is to educate each team member on concepts such as perceived usefulness, perceived risk, and create tasks that prioritizes maximizing these values. Then, allocate resources such as budget and manpower to refine marketing programs and contents towards word-of-mouth activities. After the program is implemented, review at every end of the year, compare the number of platform users and compare it to the previous data. Then, add the new yearly data to the model to improve the model, and adjust the variables accordingly to improve the model accuracy.

Table 3
Implementation Plan

No	Activities	2023		2024			
		Q3	Q4	Q1	Q2	Q3	Q4
1	Introduce the model to every member of the sales and marketing team to emphasize points of perceived usefulness and perceived risk						
2	Coordinate with design and engineering team to further develop the platform towards better ease of use						
3	Design marketing programs and leverage technology towards incentivize word-of-mouth						

4	Review performance, add the new data to the model, adjust the model variables to better reflect the data			

Conclusion

The variables that influence the adoption of immersive technology products and services in Indonesia are Perceived Usefulness that reflect how a user sees immersive technology as useful, and Perceived Risk that reflect how a user sees the consequences of adopting an immersive technology. Perceived Usefulness itself is affected by the immersive technology's ease of use, quality, and efficacy.

The recommended strategy to maximize the adoption of immersive technology products and services of PT. SUWIR in Indonesia is by focusing on programs that increases word-of-mouth contacts, and also create promotional campaigns that focuses on increasing potential adopter's perceived usefulness and perceived risk

BIBLIOGRAPHY

B.U., D., B.O., O., N.N., S., & S.O., U. (2021). Integrating Trust into Technology Acceptance Model (TAM), the Conceptual Framework for E-payment platform acceptance. British Journal of Management and Marketing Studies, 4(4), 34–56. https://doi.org/10.52589/bjmms-tb3xtkpi

Ball, C., Huang, K.-T., & Francis, J. (2021). Virtual reality adoption during the COVID-19 pandemic: A uses and Gratifications Perspective. *Telematics and Informatics, 65*, 101728. https://doi.org/10.1016/j.tele.2021.101728

Bass, F. M. (1969). A new product growth for model consumer durables. Management Science, 15(5), 215–227. https://doi.org/10.1287/mnsc.15.5.215

Bastan, M., Zarei, M., Tavakkoli-Moghaddam, R., & G., H. S. (2021). A new technology acceptance model: A mixed-method of grounded theory and system dynamics. Kybernetes, 51(1), 1–30. https://doi.org/10.1108/k-03-2020-0127

Ciprian Firu, A., Ion Tapîrdea, A., Ioana Feier, A., & Drăghici, G. (2021). Virtual reality in the automotive field in industry 4.0. Materials Today: Proceedings, 45, 4177–4182. https://doi.org/10.1016/j.matpr.2020.12.037

Fan, X., Jiang, X., & Deng, N. (2022). Immersive Technology: A meta-analysis of augmented/virtual reality applications and their impact on tourism experience. Tourism Management, 91, 104534. https://doi.org/10.1016/j.tourman.2022.104534

Hidayat, D., Pangaribuan, C. H., Putra, O. P., & Taufiq, F. J. (2021). Expanding the technology acceptance model with the inclusion of trust and mobility to assess e-wallet user behavior: Evidence from OVO consumers in Indonesia. IOP Conference Series: Earth and Environmental Science, 729(1), 012050. https://doi.org/10.1088/1755-1315/729/1/012050

Higueras-Castillo, E., Liébana-Cabanillas, F. J., & Villarejo-Ramos, Á. F. (2023). Intention to use e-commerce vs physical shopping. difference between consumers in the post-COVID era. Journal of Business Research, 157, 113622. https://doi.org/10.1016/j.jbusres.2022.113622

Horvat, A., Fogliano, V., & Luning, P. A. (2020). Modifying the bass diffusion model to study adoption of radical new foods–the case of edible insects in the Netherlands. PLOS ONE, 15(6). https://doi.org/10.1371/journal.pone.0234538

Jean, W. C. (2022). Virtual and augmented reality in neurosurgery: The evolution of its application and study designs. World Neurosurgery, 161, 459–464. https://doi.org/10.1016/j.wneu.2021.08.150

McKinsey & Company. (2020, October 5). *How COVID-19 has pushed companies over the technology tipping point-and transformed business forever*. McKinsey & Company. https://www.mckinsey.com/capabilities/strategy-and-corporate-

finance/our-insights/how-covid-19-has-pushed-companies-over-the-technology-tipping-point-and-transformed-business-forever#/

Park, M., & Yoo, J. (2020). Effects of perceived interactivity of augmented reality on consumer responses: A mental imagery perspective. Journal of Retailing and Consumer Services, 52, 101912. https://doi.org/10.1016/j.jretconser.2019.101912

Qin, Y. (2021). Attractiveness of game elements, presence, and enjoyment of mobile augmented reality games: The case of pokémon go. Telematics and Informatics, 62, 101620. https://doi.org/10.1016/j.tele.2021.101620

Suh, A., & Prophet, J. (2018). The state of immersive technology research: A literature analysis. Computers in Human Behavior, 86, 77–90. https://doi.org/10.1016/j.chb.2018.04.019

Sun, C., Fang, Y., Kong, M., Chen, X., & Liu, Y. (2022). Influence of augmented reality product display on consumers' product attitudes: A product uncertainty reduction perspective. Journal of Retailing and Consumer Services, 64, 102828. https://doi.org/10.1016/j.jretconser.2021.102828

Taherdoost, H. (2018). A review of technology acceptance and adoption models and theories. Procedia Manufacturing, 22, 960–967. https://doi.org/10.1016/j.promfg.2018.03.137

Usman, H., Mulia, D., Chairy, C., & Widowati, N. (2020). Integrating Trust, religiosity and image into technology acceptance model: The case of the islamic philanthropy in Indonesia. Journal of Islamic Marketing, 13(2), 381–409. https://doi.org/10.1108/jima-01-2020-0020

Zhou, Y., Chen, J., & Wang, M. (2022). A meta-analytic review on incorporating virtual and augmented reality in museum learning. Educational Research Review, 36, 100454. https://doi.org/10.1016/j.edurev.2022.100454