

Engagement and Resource Considerations in Developing and Implementing Mobile Health Technologies for COVID-19 Pandemic: Filipino Developers' Perspectives

Aldren B. Gonzales, RN, MSc,¹ Razel G. Custodio, RN, MSc,²
Marie Carmela M. Lapitan, MD³ and Mary Ann J. Ladia, PhD³

¹Medical Informatics Unit, College of Medicine, University of the Philippines Manila

²National Telehealth Center, National Institutes of Health, University of the Philippines Manila

³Institute of Clinical Epidemiology, National Institutes of Health, University of the Philippines Manila

ABSTRACT

Objective. This paper aims to provide a better understanding of the different engagement, cost, and resource considerations in developing and implementing mHealth solutions in the Philippines during the COVID-19 pandemic.

Methods. First, six participants completed a form to document the estimated costs of developing a pseudo mobile application with features to mitigate the pandemic. Second, ten key informant interviews determined the facilitators, barriers, and resource requirements in developing mHealth tools.

Results. The average cost estimate to develop and roll out a mobile application with public health and epidemiology features is Php 4,018,907 (US \$78,650). The analysis of the interviews resulted in 12 themes organized in three domains: 1) facilitators and barriers in developing and sustaining mHealth solutions; 2) costs of sustaining mHealth technologies; and 3) factors affecting the costs of development and maintenance of mHealth technologies.

Conclusion. While differences in the cost estimates are evident, it provides a ballpark figure and the different factors that implementers need to sustain and maintain an mHealth solution. This paper hopes to inform policies and practices in engaging technology solution partners and in scaling up mHealth technologies.

Keywords: mobile health, COVID-19, costs and cost analysis

INTRODUCTION

Due to the COVID-19 pandemic, there has been a drastic increase in the demand for technology-based solutions to reinforce public health measures. In particular, mobile health or mHealth technologies have been used for early detection, fast screening, patient monitoring, information sharing, education, and treatment management in response to the outbreak.¹

mHealth is defined by the Global Observatory for eHealth of the World Health Organization as “medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices.”² While this definition is often used, it is not yet widely accepted and is continuously evolving (e.g., the inclusion of monitoring use case for biological changes in the body).³ mHealth has gained more attention during the pandemic because of the high mobile



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Corresponding author: Aldren B. Gonzales, RN, MSc
Medical Informatics Unit
College of Medicine
University of the Philippines Manila
547 Pedro Gil Street, Ermita, Manila 1000, Philippines
Email: abgonzales2@up.edu.ph
ORCID: <https://orcid.org/0000-0002-7445-7789>

phone penetration, accessibility of smartphone technologies (e.g., native mobile applications, Bluetooth, camera for taking pictures and video conferencing, Global Positioning Service (GPS)), as well as availability and mobile phone's capacity to connect to the Internet – all are helpful in designing mobile-based tools.^{4,6}

In the Philippines, various mHealth solutions were likewise developed and implemented. The widely used mobile applications have contact tracing, health declaration/symptom tracker, and telehealth functionalities. During the first two quarters of 2021, two key functions of government-initiated mobile applications were implemented to contain the outbreak – public awareness measures and health monitoring.⁷

Many of the mHealth solutions were new, designed, and developed during the early phase of the pandemic. To get these mHealth tools running, the national and local government units and private organizations leveraged existing human resource capacity and established new partnerships to develop and implement mHealth solutions. Software developers and other information technology (IT) professionals were engaged and since then have played a vital role in the availability and usefulness of digital health tools. They innovated to respond to the needs of the population and requirements of the government.^{8,9}

On the other hand, the different policy and guidance levers¹⁰⁻¹² on its use (e.g., the requirement to use a mobile app or scan a QR code to complete a health declaration form before entering establishments) have sped up the implementation and adoption of mHealth. However, the lack of early guidance on standards and development resulted to the disaggregated and uncoordinated implementation in many countries.¹³ For example, in the Philippines, many cities and establishments have developed and implemented their own contact tracing applications. The localized implementation, coupled with the urgency in implementing digital solutions, made it hard for local government units and healthcare systems to plan and execute development as well as evaluate the cost and resource requirement in implementing and scaling up mHealth technologies.

Following the perspectives of Filipino developers who are heavily involved in technology development during the COVID-19 pandemic, this paper aims to better understand the different engagement, cost, and resource considerations in developing and implementing mHealth solutions. Engagement could include partnering/collaborating, acquiring services, commissioning, or consulting for technology development. The results of the study will inform government units, programs, and payers of the costs and other considerations in the development and use of mHealth services, especially in scaling up current technologies, and expanding the application of mHealth solutions for other purposes.

MATERIALS AND METHODS

The researchers used two data collection methods: 1) survey to solicit cost estimate, and 2) key informant interviews. Data were collected from January until February 2022.

Context

This study forms part of the rapid assessment of mHealth technologies in the Philippines project commissioned by the Philippines Department of Health – Health Technology Assessment Council (DOH-HTAC) to gain more understanding of mHealth's use during the COVID-19 pandemic in the Philippines.

Participant selection

As part of the larger project, the researchers identified COVID-19-related mHealth solutions implemented in the Philippines through literature review and market scan. Software developers and other information technology-affiliate professionals (e.g., project and product managers) acting as consultants or employed by organizations who developed and/or implemented mHealth solutions during the pandemic were recruited using convenience sampling. Invitations were sent to 14 developers who were identified in the review and market scan, and whose information is publicly available. Ten participated in the key informant interview while only six submitted cost estimates due to the sensitive nature of software development costs. Four affiliated with private companies declined. Informed consent was obtained from all subjects.

Survey to solicit cost estimate

The research team developed and pretested a cost estimate form to capture amounts associated with the different stages and categories of development, including infrastructures and services to implement a mobile-based application. The form categorized the costs into 1) planning, 2) design, 3) features, 4) infrastructure, 5) application administration, 6) testing, 7) deployment, and 8) other infrastructure, equipment, and services. The last category allowed the respondents to identify additional costs that are not part of the other categories. The respondents were asked to calculate cost estimates based on their internal costing protocol and/or personal costing knowledge. The form included a guide that describes the categories. The participants were oriented during their interview, and questions about the form and the requirements were answered.

The cost estimate form was accompanied by a request for a cost estimate document that describes the requirements, functionalities, and implementation considerations (e.g., the number of users) of a pseudo-COVID-19 application that will be developed to facilitate uniformity in format and scope of cost. The pseudo app's major features were based on the common features identified in the literature review and market scan. This includes contact tracing, symptom check-

ups, daily passport, education, information dissemination, and case management. Details of the features and other cost categories are further explained. The same specification was provided to all the respondents. Out of the six responses, one was excluded because of incomplete data, making it incomparable with other submissions.

Key informant interview

Using an approved and pretested guide, the researchers conducted ten key informant interviews online using a secured audio and video meeting platform with an average duration of one hour each. The objective was to understand the facilitators, barriers, cost, and resource requirements in developing mHealth tools.

After transcribing and translating to English, the research team coded the interview transcripts using NVIVO 12. The team used the cyclical coding approach¹⁴, initially coding the transcripts using the structure of the interview guide. Notes taken by the interviewer and the notetaker were also used to develop the codebook. Frequent reviews were conducted. Team members suggested and discussed additional codes to capture relevant differences and cycled back to ensure the codes were applied consistently to previously coded transcripts. The team continued iterating on early potential themes utilizing some of the well-established techniques, including repetition (e.g., if a concept was expressed more than three times) and emphasis (e.g., if respondents particularly engaged with or dedicated significant time to a concept). The research team maintained a running list of themes and domains, making edits and consolidating them when appropriate.

RESULTS

Characteristics of the participants

The characteristics of the ten participants are summarized in Table 1. The information of each participant provides context on their cost estimates and engagements, including resource requirement perspectives. The participants are mostly young professionals with a median age of 31 years. Eight are males. Seven are directly involved in software development (e.g., software developer, project manager, product manager), while three have management roles in software development companies (e.g., CEO, IT director, operations manager). Six came from a private software development house, two from an educational institution, one from a private health system (network of hospitals and clinics), and one works as a consultant/freelance software developer. All the participants have developed and implemented different mHealth solutions used during the pandemic, such as those designed for contact tracing, health declaration, and telehealth.

Cost of Developing mHealth Application

The total cost estimates showed a wide range, as summarized in Table 2. Based on the high-level requirements, the average cost estimate to develop and roll out a mobile application with public health and epidemiology features is Php 4,018,907 (US \$78,650). The lowest cost estimate is Php 1,957,837 (US \$38,315) from a project manager working for a health IT-focused research unit based in a public university. On the other hand, the highest estimate is Php 13,322,000 (US \$260,712) from a product manager

Table 1. Characteristics and Background of Study Participants

Code	Participation		Age, Sex	Professional Background, Organization	COVID-19 mHealth Tool Developed
	Cost Estimate	KII			
D1	✓	✓	32, M	Software developer, Freelancer	Mobile-based contact tracing application
D2	✓	✓	37, M	Project Manager and Business Analyst, Health IT-focused research unit based in a university	Mobile-based contact tracing application, health declaration tool
D3	✓	✓	25, M	Software Developer, Health IT-focused research unit based in a university	COVID-19 contact tracing tool, COVID-19 pediatric patients registry
D4	✓ (excluded)*	✓	30, M	Engineering Manager, Private software development company	COVID-19 resource need aggregator
D5		✓	34, M	Project Manager, Private software development company contracted by an LGU	Mobile-based and web-based contact tracing application, health declaration tool
D6		✓	23, F	Operations Manager, Private software development company contracted by an LGU	Mobile-based and web-based contact tracing application, health declaration tool
D7		✓	42, M	IT Director, Private software development company contracted by an LGU	Mobile-based and web-based contact tracing application, health declaration tool
D8	✓	✓	29, F	Product Manager, Private software development house with international clients	Mobile-based mental health resource tool, COVID-19 resource need aggregator
D9	✓	✓	28, M	Project Manager, Largest health system with a network of hospitals and clinics in the Philippines.	Health system mobile and web-teleconsultation and telehealth services
D10		✓	33, M	Founder and CEO, Private Artificial Intelligence (AI) Company in the Philippines	Chatbot for COVID-19 using AI

*the participant submitted a cost estimate but not included because it is incomplete

Table 2. Cost of Mobile Application Development per Respondent and per Phase/Category (in Php)

Category	D1	D2	D3	D8	D9	Average cost
Planning	480,000 (5.6%)	97,141 (5.0%)	80,000 (2.4%)	94,000 (0.7%)	160,000 (7.3%)	182,228 (3.1%)
Design	600,000 (7.0%)	60,434 (3.1%)	270,000 (8.1%)	48,000 (0.4%)	80,000 (3.7%)	211,687 (3.6%)
Features	6,480,000 (75.3%)	997,464 (50.9%)	2,520,000 (75.4%)	3,560,000 (26.7%)	424,000 (19.5%)	2,796,293 (47.6%)
Infrastructure	480,000 (5.6%)	198,787 (10.2%)	82,800 (2.5%)	5,000,000 (37.5%)	280,000 (12.9%)	1,208,317 (20.6%)
App Administration	400,000 (4.7%)	72,000 (3.7%)	20,000 (0.6%)	1,320,000 (9.9%)	224,000 (10.3%)	407,200 (6.9%)
Testing	80,000 (0.9%)	101,794 (5.2%)	180,000 (5.4%)	340,000 (2.6%)	280,000 (12.9%)	196,359 (3.3%)
Deployment/Roll-out	80,000 (0.9%)	30,217 (1.5%)	48,000 (1.4%)	340,000 (2.6%)	140,000 (6.4%)	127,643 (2.2%)
Other infrastructures, equipment, and services needed	-	400,000 (20.4%)	140,000 (4.2%)	2,620,000 (19.7%)	588,992 (27.1%)	749,798 (12.8%)
Total	8,600,000	1,957,837	3,340,800	13,322,000	2,176,992	4,018,907

Table 3. Breakdown and Average Cost Associated with each Feature, per Participant (in Php)

Features	D1	D2	D3	D8	D9	Average
Contact tracing	1,440,000	199,493	560,000	600,000	112,000	582,299
Case management	1,440,000	199,493	560,000	520,000	56,000	555,099
Daily passport	1,440,000	199,493	280,000	680,000	56,000	531,099
Education and information dissemination	720,000	99,746	280,000	960,000	56,000	423,149
Employee and visitor symptom checkups	720,000	199,493	560,000	240,000	112,000	366,299
User management	720,000	99,746	280,000	560,000	32,000	338,349
Total	6,480,000	997,464	2,520,000	3,560,000	424,000	2,796,293

working for a private software development house with international clients.

Examining the cost estimate for each category, the majority of the costs (48%) are associated with developing the major features of the mobile application. Except for participant D8, the cost for developing the identified features had the highest percentage for all estimates. Infrastructure requirement (21%) and other infrastructures, equipment, and services (13%) followed. Infrastructure requirements are costs associated with server capacity, third-party application programming interface (API) integration, and data encryption/security. For other necessary infrastructures, equipment, and services, the examples mentioned by the respondents are testing devices, training, project management tools, and costs associated with the software release. The lowest costs are related to the deployment/roll-out (2%), testing (3%), and design (4%).

Focusing on the cost of developing the core features of the pseudo mobile application (Table 3), the highest estimate is Php 6,480,000 (US \$126,814) from D1 who is a freelancer, while the lowest is Php 424,000 (US \$8,297.68) from D9 who is a project manager from a health system. Looking at the average cost of each feature, contact tracing (Php 555,099; US \$10,863.3), case management (Php 555,099; US \$10,863), and the daily passport (Php 531,099; US \$10,394) are the costliest to develop. Fewer resources may be needed for setting up user management (Php 338,349; US \$6,621) and developing the employee and visitor symptom checker (Php 366,299; US \$7,168) features.

Qualitative analysis of the key informant interviews

The analysis of the ten key informant interviews identified 12 themes, which are organized into three domains: 1) facilitators and barriers in developing and sustaining mHealth solutions; 2) factors affecting the costs of development and maintenance of mHealth technologies; and 3) costs of sustaining mHealth technologies. Table 4 provides an overview of the domains, themes, and sample quotes.

Domain 1: Facilitators and barriers in developing and sustaining mHealth solutions

Domain 1 describes the different factors and conditions that enabled or challenged the development and implementation of mHealth technologies. To support the pandemic response in the Philippines, the developers themselves initiated the development of digital health solutions, including mHealth tools, for various use cases. For others, they prioritized mHealth tools to continue providing services such as a telehealth application. As one of the participants (D9) shared, they prioritized the development of a telehealth tool because of the *“necessity to have a platform to allow our patients to connect with us because there was a really huge decline in terms of our patient census... and the doctors aren’t reporting to the hospital because of the fear with COVID-19.”*

Participants from both a government-affiliated university and private developers volunteered to develop mHealth solutions to address the many challenges brought about by the COVID-19 pandemic. A participant from a private

Table 4. Domains and Associated Themes from the KII with Developers/Project and Product Managers

Domains	Themes
Domain 1: Facilitators and barriers in developing and sustaining mHealth solutions	Theme 1.1: The pandemic promoted innovations and accelerated implementation of mHealth technologies
	Theme 1.2: Organizations and individuals are willing to develop mHealth solutions related to COVID-19 for free
	Theme 1.3: Connection or relationship with government units is both an advantage and incentive for private developers
	Theme 1.4: Politics, red tape, and existing policies around the procurement of IT services limit engagement of private software development companies
	Theme 1.5: Lack of coordination of ongoing efforts that led to saturation of the market
	Theme 1.6: At some point, the value of a certain technology implemented during the pandemic diminishes and new features can help them remain significant
Domain 2: Factors affecting the costs of mHealth development and implementation	Theme 2.1: Human resource is the biggest factor that affects the cost of mHealth development
	Theme 2.2: Features and requirements set the timeline and timeline influences features, requirements, and resources
	Theme 2.3: Infrastructure costs are influenced by the number of users, security features, and maintenance work
	Theme 2.4: The more users, the higher the requirement for infrastructure, maintenance activities, and customer support
Domain 3: Costs of development and maintenance of mHealth technologies	Theme 3.1: How much does it cost to develop mHealth technologies in the Philippines?
	Theme 3.2: There are different ways to generate income to sustain mobile health applications

software development house (D4) mentioned, “*we wanted to do something related to the expertise of the company, and that [the app developed] is what we thought is needed... It is not developed to get profit for it. It is really to help.*” However, while the original intention is to assist the government response, the end goal for those in the private sector is still to generate profit to sustain their businesses. Once their technology is adopted, it opens doors to engage in future projects: “*it became an incentive to participate in this kind for private companies because we can have a chance to put one foot inside the department involved*” (D6). Those with existing relationships with organizations and government units, that prior engagement made it easier to get contracted and provide the technology solution.

The participants also raised a number of challenges. First, the private developers had to deal with politics and red tape across the government processes, which became more evident during the pandemic. For example, one of the participants (D8) had a firsthand experience where he describes as a common occurrence “*...there was a different vendor politics happening during the project, which is very common... I am not sure what happened, but usually, the influence will come from above [higher position].*” They believe that the unclear processes and excessive bureaucracy in the procurement process also caused delays in the development and implementation. Second, it was recognized that there was a lack of coordination among national agencies and projects that support similar use cases. The lack of coordination and harmonization resulted in duplication and saturation of the market. While there are other factors, the lack of coordination by the government is attributed to the retirement of some of the technologies

developed. Last, the use and value of mHealth technologies diminish as the pandemic takes different phases. For example, during the start of the pandemic, facilities ran out of personal protective equipment. An app was created to crowd-source and connect facilities with suppliers. However, they eventually had to retire it because “*around the end of 2020, the supplies have normalized, we were able to catch up with the need. With that, it is like there’s no value in a sense to crowd-source during that time... the specific need [for the application] is not present anymore*” (D4).

Domain 2: Factors affecting the cost of mHealth development and implementation

First, all the participants agreed that software developers’ salaries contribute the biggest to mHealth development cost. As mentioned, “*the developers’ salary takes a big chunk of the development cost... this includes project managers, product manager, testers, quality engineers too*” (D8). It was shared that the human resource cost may reach around three-fourths of the total budget.

Second, the set of software requirements and features of the mHealth technology are also a big factor in cost: “*these are really a big factor and its complexity – because that is what makes it expensive. That makes the project longer and hard. It is not the number of features since sometimes, there are many features, but all are basic compared to a project with small number of features but complex...*” (D4). The requirements also influence the completion period, influencing the cost of personnel services. As recommended, the complexity of the solution and the timeline should be set and agreed upon during the start of the project to minimize risks and to have

more grounded expectations on the completion and cost of the mobile app.

Based on the participants' examples, doing a rapid development cycle with scalability in mind and releasing a minimum viable product to show that the application works (i.e., proof of concept) might be more appropriate when the goal is to release a solution quickly. In rapid development cycle, the development is focused only on the minimum and basic functionalities that would address the identified problems or processes for automation. However, it is dependent on the need and requirements set by the implementer and may not work in all use cases.

Third, developing mHealth technologies requires resources dedicated to infrastructure, including the services and tools to implement the solution thoroughly. Among the infrastructure needs, the participants frequently mentioned the server cost. As shared by D6, *"if the demand increased and we are now expecting around 10,000 to 100,000 a day user registrant, we need to assess. Do we need to increase the processor, memory, and storage?"*

Developers also need an integrated development environment (IDE) – the tool that software developers use to develop applications and project management tools. For testing, it requires simulators and physical devices depending on the requirement and design of the application. For example, if the application is developed for iOS and Android, an iPhone and a phone that runs Android should be available. Other infrastructure requirements are dependent on the features of the technology. Examples are storage for QR code images, subscription to API for email, and short messaging services for notifications. Implementation should also consider the cost of securing the server, encryption tools, and other security tools. This is very important since mobile applications only serve as a gateway to the servers that handle and process data.

Lastly, the participants agreed that as the user base increases, the infrastructure should scale up to accommodate. The server/s and associated infrastructure requirements (e.g., Internet connectivity) should be functional, allowing all concurrent users to access the application without any problem. The application should also be robust in handling the expected number of requests effectively and efficiently. As the number of users increases, the implementation should also allocate resources for customer support. A participant (D8) recommends *"once your application is getting bigger and the user base is expanding, 50,000 users you should have three levels of maintenance and customer service: L1, L2, L3."*

Domain 3: Cost of developing and maintaining mHealth technologies

It is hard to provide a fixed price for mobile-based technologies since their development has been very dynamic, and the features and requirements continue to change. Instead, many developers provided the costs of their previous projects in health and other industries. For a telehealth platform

developed for a health system, one of the participants (D9) shared that *"the development of the telehealth platform itself is around three to five million, and the operational expenses are about two to three million per year."* Another example shared is a mobile banking application developed for one of the top 10 banks in the Philippines that facilitates online bank transactions (e.g., account view, money transfer). The bank contracts out the development and maintenance, and pays the software development house five million pesos per month. The team managing the application has 25 developers together, including those from other vendors and native staff.

The developers also mentioned a number of ways to finance mHealth technologies. This includes pro bono/volunteer work, as a form of the company's corporate social responsibility, funding from the government units (national and local), and service fees. One of the participants (D6) from the private sector that developed a contact tracing app for a local government unit (LGU) shared their model: *"Our business model is to sell our solutions, the system, to the LGU. It is up to them if they want to add advertisement [in the mobile application]."* While they recognized that adding advertisements generated income, it was unused for the COVID-19-related mobile applications to maintain users' trust. Most of the downloadable mHealth applications are already paid for by the implementing organization (e.g., local government unit). Moreover, publishing paid applications may discourage people from downloading and using the app. One participant highlighted equity sharing between the government and private software development companies as another option for sustaining the technology over time.

DISCUSSION

The results show that the cost of developing and implementing mHealth solutions varies depending on the capacity of the software developers, requirements and features, infrastructure and services, number of users, maintenance, and support. While we were not expecting wide variance, we recognize that estimating cost is more than just understanding the features and that the factors mentioned above need to be considered. The result is reflective of how different the costs are for mHealth implementation in some of the literature that we found depending on their design and implementation. For example, in a mobile health application designed for counseling pregnant women and nursing mothers enrolled in a program, the annual cost for rolling out the program in two blocks of a district in India was 12.1 million INR which is around Php 9,594,700 (US \$~191,894).¹⁵ Another study reported that the total annual start-up cost for a mobile-based job aid for maternal and child health is USD 45,647. This includes software development costs, vehicles, mobile handsets, other IT equipment, and training cost.¹⁶

Considering the average mobile application development cost outside of the Philippines, the two highest estimates are the closest – Php 13,322,000 (US \$260,712)

and Php 8,600,000 (US \$162,540). In an industry survey, developing mHealth, from conception to launch, can cost approximately US \$425,000.¹⁷ In a 2014 survey with mobile leaders and Chief Information Officers, the average cost per mobile app is US \$270,000.¹⁸ Two other industry surveys resulted to lower cost – a median price of US \$171,450¹⁹ and an average of US \$140,000²⁰ per application.

In general, when looking at the costs, it is crucial to consider several items that can influence the estimates. One major factor that should be considered is the background of the participants – something that the researchers cannot control and that can have a major impact on the amounts. For example, we may assume that the freelancer who provided the highest estimate might not have technical services and infrastructure ready compared to individuals in software development houses where all the necessary infrastructure, services, and support are available. Since the estimates are largely based on associated man-hours per task, existing rates from participants' workplaces can largely influence the cost. For example, participants affiliated with universities provide rates that are relatively lower than those from private software development houses.

In looking at the breakdown, we see that majority of the costs are associated with the features and the infrastructure. Even though the costs are different, when we look at the percentages, we recognize agreements on how much resources should be allocated on each category. This is further validated by the results of the KII which also described how features and certain infrastructure needs can influence the cost.

Considering the different cost influence presented in this study, the limited available reports of cost on implementing mHealth, and the differences even in the industry surveys, we argue that it is hard to set a benchmark. We also do not present the results of this study to be treated as such. However, this information could be helpful in planning by providing local estimates and understanding better how the factors could interplay in the cost as organizations develop or scale up mHealth solutions.

Aside from costs, the study also recognized a number of considerations in engaging software developers. The results highlight the importance of facilitating incentives, removing barriers, and incorporating inputs from software developers who play a crucial role in the pandemic response.

Many of the findings, including those related to procurement politics and incentives were expected. However, two themes stood out. First, the developers' experiences highlighted the importance of coordination in technology development during a pandemic. Unlike normal software releases where developers launch their solutions on their own, the pandemic caused simultaneous development and releases – resulting in multiple solutions for the same purpose. Learning from this, a more coordinated approach and early provision of consensus guidance (e.g., framework, semantic, and interoperability standards) from responsible government entities could have addressed effort duplication

and market saturation. Second, the participants also raised an important point about how the value of technology changes over time. This perspective provided a better understanding of how technologies should be designed for sustainability. For mHealth to stay relevant during a pandemic, it should contain features its user base would need to use as the pandemic progresses to different stages.

In the third domain, the themes highlighted the need to think beyond the cost of development and also allocate resources or set a strategy to maintain mHealth technologies over time. Organizations may need to think of the best suitable strategy to support maintenance cost based on their tool, funding source, use case, and users. In the case of the pandemic, we agree with the inputs from the participants that mHealth business strategies should ensure that technologies remain trusted and open (or free), and assistance with phone ownership²¹ should be available to allow equitable access to mHealth tools.

The findings of this study related to cost reflect the large investments that organizations need to make to implement and maintain mHealth. As such, like any other healthcare intervention and investment in health programs, it is necessary to ensure that it produces positive outcomes and cost-effective.^{16,22}

Limitation

While the study addressed its objectives and produced information as the bases for future mHealth implementation, it could benefit more from the active participation of those who can provide cost estimates. The majority of the participants came from the private sector, and the composition could have influenced the study results.

CONCLUSION

This is the first study in the Philippines to document considerations in the implementation of mHealth technologies from the software developers' perspectives. It is also the first effort in the Philippines to understand the cost of implementing mHealth solutions. The result indicates that mHealth cost is influenced by a number of factors that should be considered when developing, implementing, and scaling up the technology. The results also highlight the importance and role of the government in actively engaging Filipino technology solution providers in advancing digital health solutions.

As the country progresses to the next phase of the pandemic, we expect that mHealth solutions will continue their role in keeping the population healthy and safe. This study hopes to inform policies and practices of the government and private entities in engaging technology solution partners and scaling up mHealth solutions. Implementers like government units should continue providing incentives and removing barriers for better partnership and collaboration.

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Statement of Authorship

ABG, RGC, and MCML made substantial contributions to the conception and design of the study with inputs from MAJL. MCML served as the principal investigator. ABG and RGC made substantial contributions to the data collection, analysis, and interpretation of the study data with inputs from MAJL. The manuscript was drafted by ABG and it was revised critically for important intellectual content by all authors. All authors approved the final version of the manuscript.

Author Disclosure

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