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Featuring REDCap Mobile App in National Health and Morbidity Survey (NHMS): A Lesson-Learned

Research Electronic Data Capture

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1.0 INTRODUCTION

1.1 About NHMS

The National Health and Morbidity Survey (NHMS) conducted by the Institute for Public Health (IPH), National Institutes of Health, Ministry of Health Malaysia (NIH Malaysia), is a comprehensive and periodic nationwide study aimed at assessing the health status, health behaviours, and healthcare utilization patterns of the household population in Malaysia. The survey gathers data on a wide range of health indicators, including non-communicable diseases, infectious diseases, nutrition, lifestyle factors, healthcare access, and utilization. Through its rigorous data collection and analysis, NHMS serves as a crucial tool for policymakers and healthcare authorities to formulate evidence-based strategies and policies for improving public health and healthcare services in Malaysia.[1]

1.2 Introducing REDCap in NHMS

NHMS 2023: Non-communicable Diseases (NCD) and Health Care Demand (HCD) marked the new milestone in NHMS when Research Electronic Data Capture (REDCap) Mobile App (RMA) platform was utilised for the first time, not only in the history of IPH, but also in NIH Malaysia.

REDCap is a secure web-based application for data collection and management in research studies, offering researchers a user-friendly platform to create electronic data capture forms, manage participant data, and aid in data analysis and reporting.[2,3]

The RMA is a companion tool that enables data collection directly from mobile devices such as smartphones and tablets, allowing participants or researchers to enter data on-the-go, even offline. While both REDCap and the RMA share the same data backend, the RMA offers greater flexibility in data entry beyond the confines of a desktop computer, making it particularly useful for real-time data capture in remote or dynamic research settings.[4]

1.3 RMA in NHMS 2023: NCD and HCD

The RMA is utilized solely for all twenty-three NCD's modules in NHMS 2023: NCD and HCD using 76 units Samsung Galaxy Tablet S2 (S2) and 38 units Samsung Galaxy Tablet S8+ (S8+), owned by the IPH during the face-to-face interview of data collection.

1.4 Objective for this presentation

The goal of this case study is to discuss the lessons learned during the development process, namely the difficulties faced and troubleshooting methods.

2.0 RMA DEVELOPMENT PROCESS

Designing the flow of the system, customization of more than 500 questions for these modules, constructing and developing the algorithm for the calculation, IF-condition formula and skip pattern (known as branching logic) and furnishing the cosmetic appearances of the application through HTML and CSS programming was done by the main author and assisted by the designated research assistant whose both were not having recognised information technology (IT) background. Formal training for REDCap at the intermediate level was participated by both main author and his research assistant for two days in March 2023, held in Universiti Malaya.

While the other team members of this presentation play roles in checking the functionality of the system and application as well as advising the problem-solving methodologies.

The list of main contributors in the development of this system and application is shown in Table 1, while the Gantt Chart for the NHMS 2023 IKU Questionnaire System and Application Development Process and the Module Flowchart of the RMA in NHMS 2023 are shown in Figure 1 and Figure 2 respectively.

Table 1 – List of the main contributors in the development of NHMS 2023 IKU REDCap-based Questionnaire System and Apps

Name	Designation	Role in the development process
HALIZAH MAT RIFIN	Medical Officer	Principle Investigator of NHMS 2023: NCD and HCD (Consultant in the System and App Development, previously System Manager for NHMS 2020:CDC)
MOHD RUHAIZIE RIYADZI	Environmental Health Officer	System and App Development Manager NHMS 2023: NCD and HCD
HAMIZAH MOHD MOHADIS	MySTEP Personel	Assistant to System and App Development Manager NHMS 2023: NCD and HCD
HAMIZATUL AKMAL ABD. HAMID	Research Officer	Data Manager (1) of NHMS 2023: NCD and HCD
NORHAFIZAH SAHRIL	Research Officer	Data Manager (2) of NHMS 2023: NCD and HCD

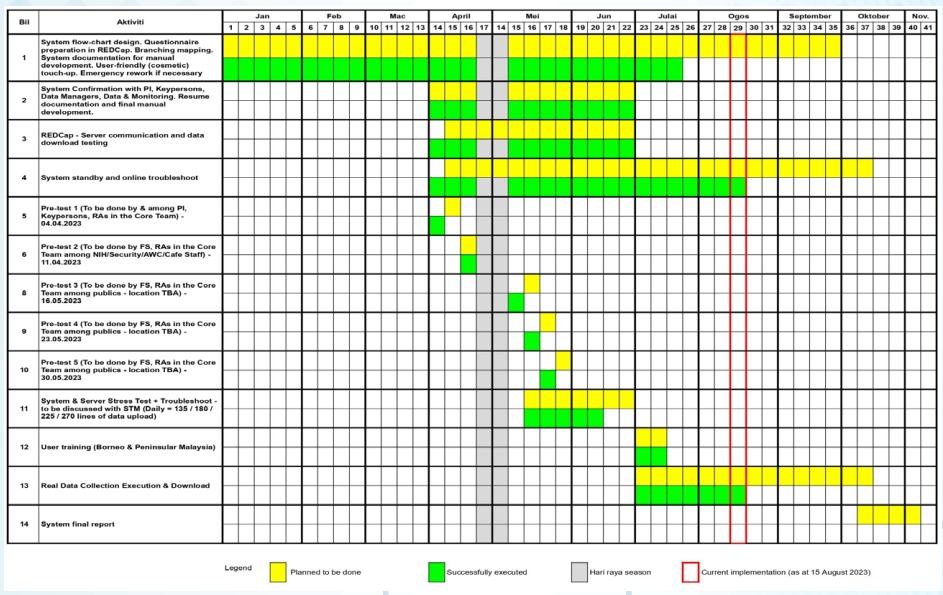


Figure 1 - The Gantt Chart for the NHMS 2023 IKU REDCap-based Questionnaire System and Application Development Process

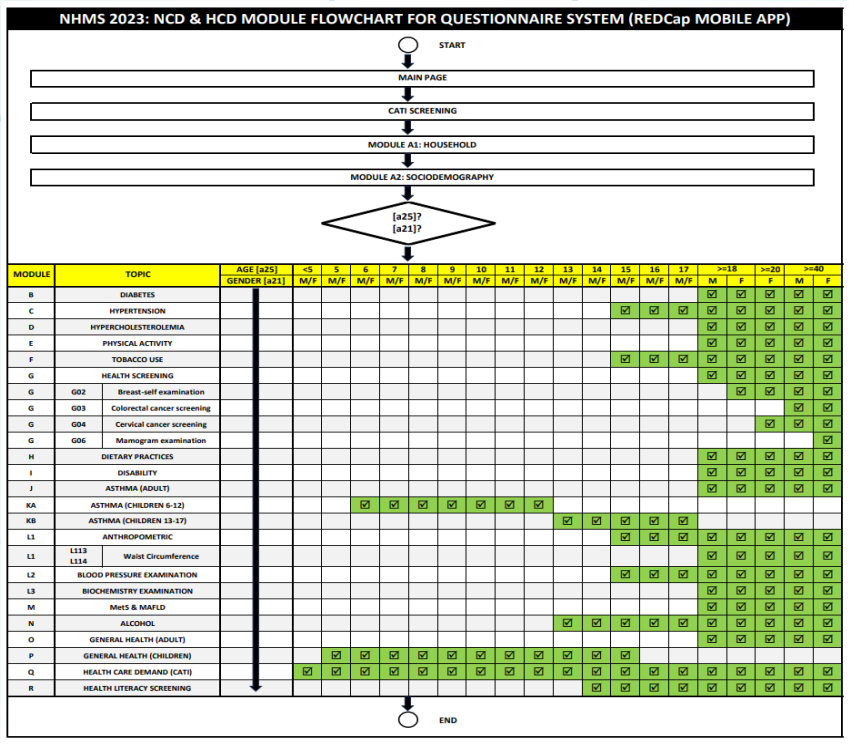


Figure 2 - The Module Flowchart for the NHMS 2023 IKU REDCap-based Questionnaire System and Application

3.0 CHALLENGES FACES IN THE DEVELOPMENT PROCESS

During several pre-tests and pilot runs, we discovered that RMA encountered various issues due to its limitations and the operating system of the tablets, especially when utilised in the S2 (purchased by the IKU for about 10 years ago), which included failures in executing complex algorithms and multi-layer nested IF calculations, as well as missing data in the @CALCTEXT action tag's function and some embedded field formats. Consequently, this disrupted its branching logic directives.

3.1 Calculation of age and the IF-Condition to either use Calculated Age or Declared Age

Age ("a25", field name: A25 [FINAL]) is the most important variable in NHMS 2023 IKU, in determining which module should be answered by the respondent (see Figure 2). "a25" should be automatically calculated from the date of birth ("a24") given using the following formula in the @CALCTEXT Action Tag:
@CALCTEXT(roundown(datediff ([a24],[iv_date], 'y')))
The initial idea for the unknown date of birth was 01/07/0000, but there is no 0000 year in the generated calendar in REDCap, so we decided to change it into 01/07/2033. If 01/07/2033 was chosen, then the exact number of age needs to be inserted manually. For RMA in several S2, problem was identified to be occurred either at the calculation of the age, or during IF-conditioned to be placed into the "a25" either calculated age or declared age. This problem affects the skip pattern (branching logic) in determining modules to be allowed to be answered by the respondent.

3.2 Complex algorithm with multilayer/nested IF-Condition, disturbing the branching logic or skip pattern

Complex algorithm with multilayer nested-IF condition calculation was used in variable "a26" (field name: A26 [FINAL]) as followed:
IF([a26_mykad]="",IF([a26_passport]="",IF([a26_otherid]="",IF([a26_choice]="","",IF([a26_choice]='-7',-7,-9)),[a26_otherid]), [a26_passport]), [a26_mykad])
This algorithm returns error in some of the RMA in S2, thus leaving blank answer in "a26". Another problem occurred when using RMA in S2 was due to the embedded field format in the REDCap. Some @CALCTEXT Action Tag in this embedded field format was not successfully captured in the downloaded CSV file.

3.3 Problem with multiple answer question and the undetected missing value

G01a was the only question in NHMS 2023 IKU with the multiple answer selection format. The format in downloaded CSV file indicates that any tick (selected) answer was given "1" as the input but untick (unselected) answer was given "0". This is quit confusing the Data Managers where any unanswered field should be indicaed with blank ("""). The initial idea for unanswered field or missing value was to place with "-6" but this not allowed in the use of RMA.

3.4 Embedded field fails to capture the @CALCTEXT Action Tags

The initial idea was to place all fields into single embedded field (L101). However, the branching logic in for the L101 [FINAL] have conflict with the branching logic of L101_A22_2 in RMA in S2, which caused this module cannot be saved, thus all instruments in NHMS 2023 IKU was not permitted to be sent to the server. This caused the fatal error in the data collection.

3.5 The overlaid questions in the Matrix Field format (as in Figure 3 below)

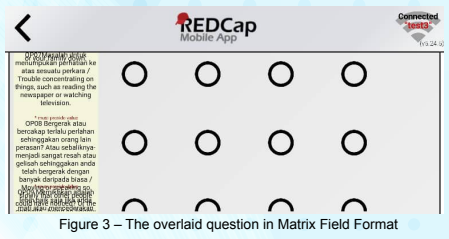


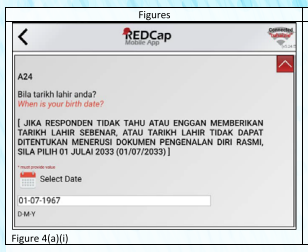
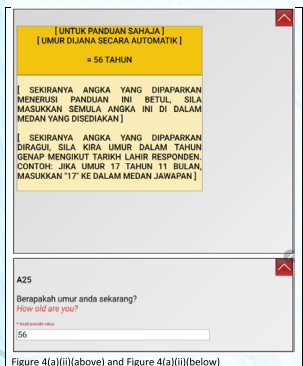
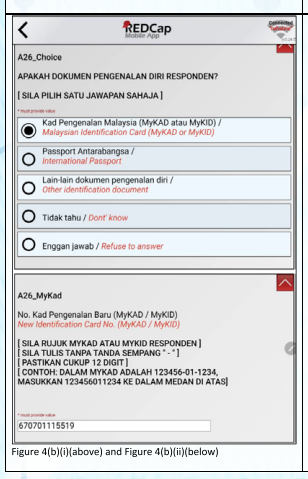
Figure 3 – The overlaid question in Matrix Field Format

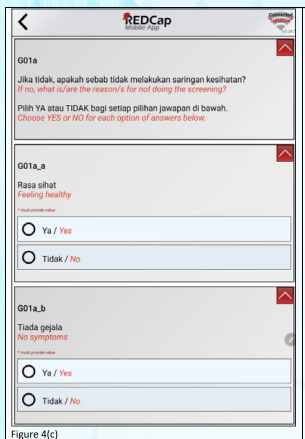
4.0 THE SOLUTION

Table 3 - The justification of choosing RMA instead of web-based online survey, despite the RMA limitation and disturbance which might be caused by the old S2

Conditions/situations	RMA	Web-based online survey
Limited internet network coverage	Data collection can be executed without any internet network coverage, except during data submission to the server and during refreshing the setup of the RMA	Requires internet network coverage to execute data collection
Data quality checking by the Field Supervisors	Can be done after face-to-face interview session ended and before data submission to the server	Cannot be done as data will be transmitted to the server in real time during face-to-face interview session
Pause and resume face-to-face interview session	The face-to-face interview session can be paused and resumed at any time without the need of any unique return code or specific link	Data collector needs to keep the different return unique code or specific link if respondent request to pause and resume later the face-to-face interview session.
Easy to select any modules from the instrument menu	Yes	Unable to do so

Based on these justification and limitation, "SIMPLE IS BETTER" is the keyword to the solution of the above challenges faced during the development phase of NHMS 2023 IKU in the REDCap platform. The embedded fields, multiple-answer fields and matrix fields were disabled, and customized into simple text box, calculated or radio-button fields, while the complex algorithm and multilayer nested IF conditions were reduced to the simple algorithm for proper calculation and smooth branching logic (see Figure 4).

Figures	Detail of final customization
 Figure 4(a)(i)	Data collector will pick the right date of birth in the field A24 (Figure 4(a)(i)). An auto - calculation of age will be executed and the age will be presented as a guide only to the data collector (Figure 4(a)(ii)). The data collector will either insert the same number or the other number recalculated using an external age calculator installed in the tablet into field A25 (Figure 4(a)(iii)).
 Figure 4(a)(ii)(above) and Figure 4(a)(ii)(below)	
 Figure 4(b)(i)(above) and Figure 4(b)(ii)(below)	The embedded field was restructured and customised into simple radio button field (A26_Choice) (Figure 4(b)(i)). Based on the answer selected, a subsequent field (either text box, etc) will be appear to be inserted with proper answer (Figure 4(b)(ii)). Therefore, no more complex algorithm utilised in this form.

 Figure 4(c)	Multiple answer question was simplified into radio-button field type, thus the value used in the downloaded CSV files were "1" and "2" (standard NHMS 2023 IKU variable value for Yes or No answer) instead of "1" and "0" just for this question (G01a) (Figure 4(c)).
Figure 4(d)	The matrix fields were restructured and customized into radio-button fields to avoid overlayed questions in the tablet interface (Figure 4(d)).

5.0 CONCLUSION

Although REDCap was recognized as a tool to design paperless and digital-based questionnaires by anyone including those without IT background 3,4, proper training must be given to and attended by those appointed as System Manager. Person with basic IT background or IT savvy person are bonuses to the developer team. Despite having sophisticated application and system is a dream to any developer to be achieved, sometimes simple structure and flow are the best especially in having limitation not only in the software aspect but also due to the age and limitation of the electronic devices.

References

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3. Harris PA, Taylor R, Minor BL, Elliott V, Fernandez M, O'Neal L, McLeod L, Delacqua G, Delacqua F, Kirby J, Duda SN. The REDCap consortium: building an international community of software platform partners. Journal of biomedical informatics. 2019 Jul 1;95:103208.
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