Improving health campaign microplanning efficiency and effectiveness with the use of a predictive analytics planning tool

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Abstract

An increasing number of nations are investing in digitizing legacy paper-based systems in alignment with the 2018 seventy-first World Health Assembly (WHA) resolution, which urges its members to adopt digital health solutions and promote the use of digital health technology. [1] In line with this World Health Organization resolution, we have developed a predictive analytics tool that has automated the paper-based health campaign microplanning system into an electronic format. Electronic collection and management of data not only reduces the clerical burden but also allows analytics such as prediction, Artificial Intelligence (AI), or machine learning algorithms to use large amounts of data to provide evidence-based recommendations.[2-3]

This study aims to determine if the use of an automated, predictive analytics tool can increase efficiency by reducing planning time, ensuring better targeting of services to those with the greatest need, and optimizing resource deployment plans.

For the integrated May 2022 health campaign, we employed a concurrent mixed methods evaluation to compare the use of the predictive analytics tool in conjunction with the current manual system of planning that uses Word, Excel, email, and WhatsApp. This nationwide integrated health campaign provided vitamin A supplements, intestinal deworming, schistosomiasis treatment, screening and treatment for malnutrition, family planning, vaccination catch-up services, and promotion of hygiene and sanitation. We supplemented our inquiry with Key Informant Interviews (KIIs), direct observation, and online surveys of health campaign experts based at the national level, and Focus Group Discussions (FGDs) with district staff responsible for health campaign implementation to gather real-world context knowledge.

We estimated that the predictive analytics tool could save the Ministry of Health approximately 10 days of face-to-face meeting time of time of senior staff. The team was unable to calculate the time spent in preparing population forecasts and supply plans as these activities were conducted by individuals who did not keep a time journal. However, based on our examination of the Excel spreadsheets, we estimate the time to complete these tasks was minimal as the MOH staff used an existing Excel spreadsheet to update the numbers.

The predictive analytics tool found that there was no relationship between the district's level of poverty and the coverage rates attained for deworming or vitamin A. The four districts with the lowest rates of poverty achieved an average coverage rate of 92 percent for Vitamin A and 95% for deworming, while Nyamasheke, the poorest district, achieved a coverage rate of 94% for Vitamin A and 101% for deworming. The highest number of severe malnutrition and oedema were most prevalent in the same poorest district. The MOH manual system of planning did not report any correlations between poverty and coverage rates. This may be caused by the fact that the majority of Rwandan health campaign planners do not view addressing vulnerable populations as the campaign's main objective according to the results of the online survey. The study also found that there was no correlation between the health

campaign budget allocated to districts and coverage rates achieved. Districts with less poverty received almost 20% - 60% more budget allocation than those with higher poverty rates.

The tool also generated other key performance indicators (KPIs) using current and past campaign data that could help with future planning. However, most of these KPIs are calculated mathematically and may not reflect the complexity of programming. While health campaign planners recognized the value of using a digital planning tool, the lack of in-country capacity, continued reliance on external technical assistance, a history of negative experiences with digital tools, and the unknown future costs of using the software were ranked as the most significant reported barriers to adoption.

Introduction and Background

Globally, health campaigns are recognized as a critical strategy for reaching large numbers of people with focused, time-limited health services, particularly when addressing outbreaks or increasing access to a specific health service, however, there is an ongoing debate about the effectiveness, efficiency, and costs of these campaigns.[4] These discussions are made more difficult by the fact that most countries, including Rwanda, use manual planning systems. These systems take a lot of time, demand intensive departmental coordination, and make it challenging to determine whether the intended goals were achieved.[5] Using digital technology to automate the micro-planning process and applying predictive analytics, Artificial Intelligence (AI), with Big Data has the potential to enhance effectiveness, increase efficiency, while decreasing costs.[6]

To meet this unmet gap, we created an end-to-end micro-planning and reporting tool/platform[1] for health campaign planning with the help of the Grant Challenges Fund (GCE) of the Bill and Melinda Gates Foundation (BMGF). The tool has automated many of the planning tasks. For example, the technology now performs tasks like forecasting and calculating the required quantities of medical supplies automatically. A dashboard keeps tabs on the districts' operational readiness for the health campaign, the status of district budget allocations, and national fund-raising status and once the results are entered into the tool, the program generates a report template with all the charts and data annexes. The MOH staff just need to write around the findings.

In addition to automating various planning operations, we have included a sizable number of publicly accessible datasets in the program[2]. The tool's predictive analytics algorithms look for patterns such as past performance, constraints to inform future operations. The technology is now provided without cost

[1] We use the word tool, platform interchangeably. It is a tool using Azure and is on a cloud platform, enabling multiple parties to access it at the same time through the internet. The tool is not downloadable and does not work on an individual's local hard drive.

[2] Datasets incorporated into the tool include GIS mapping data such as health facility locations, terrain, road networks, etc. population estimates, poverty maps, attainment of education levels by age, past health campaign plans and outputs, HMIS, LMIS and literature review data that provide information such as distance willingness to walk for health service, willingness to pay etc.

and is housed on an online platform that allows for concurrent user collaboration and departmental transparency. The tool's simulation and optimization module also make it possible to assess cost-benefit tradeoffs.[7] Annex 1 gives a summary of the instrument.

Before doing this study, we applied the tool retroactively to two previous national integrated health campaigns in Rwanda, which were held in May 2018 and October 2019. Since these campaigns had already been carried out, we gathered all the planning materials, including budgets, coverage rates, planning meeting minutes, projections for medications, etc., and used this information to reconstruct the health campaign plan using the predictive analytics tool. We used this activity to confirm that the tool functioned as intended. Additionally, we demonstrated to the Ministry of Health how they might have reached an extra two million individuals if 180 additional mobile sites had been strategically positioned within a 2-mile walking distance using the optimization and simulation module of the application. We also showed that the majority of people used the health campaign services within the first three days of the campaign's deployment according to the demand patterns. However, in neither instance were the human resources and or medical supplies adjusted to correspond with demand patterns. We correlated health campaign coverage rates and poverty data that is incorporated in the tool to reveal that only 26% of the poorest families were reached in 2018 and 21% in 2019.[8]

Although the results of our earlier analysis indicated that the tool had value, more research was required to determine whether it improved planning efficiency and effectiveness, and to gauge user acceptability, which might encourage longer-term adoption of the technology.

Objectives and Research Questions

The goal of this study was to ascertain whether using an automated, predictive analytics tool resulted in increased efficiency by cutting down on planning time, optimized resource deployment strategies, and ensured better service targeting to people who need it most.

We evaluated the tool's efficiency by looking at how much planning time it could save. We evaluated the targeting of services by examining the relationship between coverage rates and poverty distribution, and we computed resource optimization on whether the operational funds were dispersed to attain the highest coverage rates. The study also evaluated how well the tool was built, how well it addressed the customers' planning difficulties, and how keen the end users were to use this new technology for the next health campaign planning.

We conducted the study on the May 2022 nationwide integrated health campaign that offered vitamin A supplements, intestinal deworming, schistosomiasis treatment, screening and treatment for malnutrition, family planning, vaccination catch-up services, and promotion of hygiene and sanitation.[9]

Methods

A concurrent mixed-methods research methodology was used for this investigation. For the quantitative phase, we conducted a comparative evaluation with Ministry of Health workers planning the health campaign using Excel and Word and their present micro-planning procedures. While our team used the predictive analytics tool to carry out the same exercise. We then compared how the two plans performed. The initial plan called for the manual and use of the predictive analytics tool to be done simultaneously, but because our team was not informed of the dates and times of all the planning meetings or the times that the Ministry of Health staff were calculating forecasts, supply plans, etc., we were unable to use the tool concurrently. Instead, we did a retrospective analysis of the two planning applications. We compiled all planning-related documents (concept notes, meeting minutes, operational expenses, projections, supply plans, budgets, final reports, etc.) and used them to recreate the micro plan.

Three online surveys were conducted using SurveyMonkey. The first survey was a pre-test and was sent to the international healthcare logistician association (IAPHL) community. We chose this this group to pre-test our survey because they represent similar skills of those who plan health campaign. The second survey was sent to 51 of the 60 estimated potential health campaign planners. 45 participants completed the survey – a response rate of 88 percent.

The third was a follow-on user-feedback survey to which 10 out of 13 participants responded. We used the purposive sampling method that included a core group of Ministry of Health staff known to be involved in most health campaign planning and representative of the eight sub and steering committee members responsible for planning and coordinating these nationwide campaigns.

For the qualitative part of the data collection, we conducted direct observation workshop to assess the use of the tool by the 13 health campaign planners. We also conducted Key Informant Interviews (KIIs) among 10 experts with an average of 9 years of health campaign planning experience [ranging from 7 - 17 years] to under the process of health campaign planning. Thematic saturation rate sampling method was used. By the third interview, 80% of new knowledge was gathered and no additional information arose after the 7th interview.[10] Focus Group Discussions (FGDs) were conducted among 18 staff from five different districts, representing all of the four provinces and Kigali to understand health campaign planning challenges from the implementation perspective.

For data analysis and interpretation, we employed a convergence triangulation model. For each data gathering technique, we separately gathered and examined the data. The qualitative findings were utilized to support the quantitative conclusions. Annex 2 provides a breakdown of the methods used for data collection and the sample size of each method. The Rwanda Institutional Review Board (IRB) approved the study in December 2021. Data collection took place from January to June 2022. Each participant in the study provided written consent. A password-protected Google Drive folder was used to store the data, which was only available to the core team members.

Results

Over the course of 1.5 months, the Ministry of Health (MOH) staff held a total of six planning meetings, involving over 201[3] people to discuss the status of the micro-plans from March 15, 2022, to April 29, 2022. approximately 40 days were spent in these meetings.

Table 1: Comparison of person-hours between the manual system of planning versus the use of a predictive analytics platform

Intervention	Total number of people involved	Total number of planning meetings	Total number of meeting minutes	Total number of person-hours
Manual System	201	6	510	324.25
Predictive Analytics	151	5	405	250.00

Comparatively, the predictive analytics micro-planning tool took 10 days less than the manual system of planning and involved a total of 151 people instead of 201. Multiple people from the same department who were there at the meeting to just know what was going on did not need to attend the meeting because they could monitor the status of the health campaign micro plans on the online dashboard without needing to be present at these meetings. This translates into a calculated savings of about 10 days of senior staff time per campaign (most staff have an average tenure of 12 years) by using the predictive analytics platform.

The KII verified that the typical planning period lasted around two months. While many believed the success of the current health campaign planning was "depending on the diversity of the people and sector involved in the planning process," some believed the inclusion of "too many people" was an inherent weakness of the microplanning process. We were unable to determine how long it took MOH personnel to complete the forecasts and supply plans, in addition to the time spent in planning meetings. However, we can infer from the data gathered that this time was minimal because the staff simply updated the previous forecasts and supply plans by adding a simple linear projection using a standard Excel template. The same level of activity took around 15-30 minutes to complete using the predictive analytics platform.

> *"Too many people involved, leads to not everyone being trained properly and trouble getting everyone together, not to mention it is very expensive to bring all those people together".* KII participant

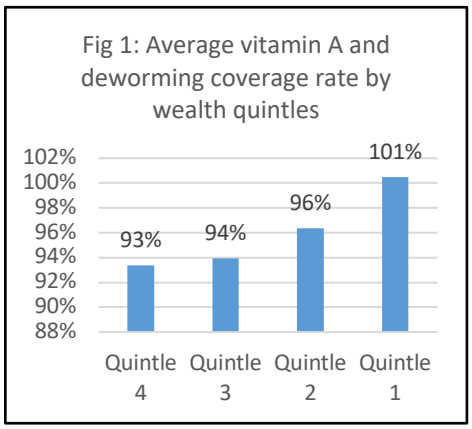
Beyond coverage rates, the manual method of planning and reporting did not calculate any additional key performance indicators that could inform future health campaign programming. The predictive analytics tool found that the district poverty rates[4], and health campaign coverage performance were shown to be inversely correlated, with poorer districts obtaining higher

> *"The major strength for me is the diversity of people involved in the preparation."* – KII participant

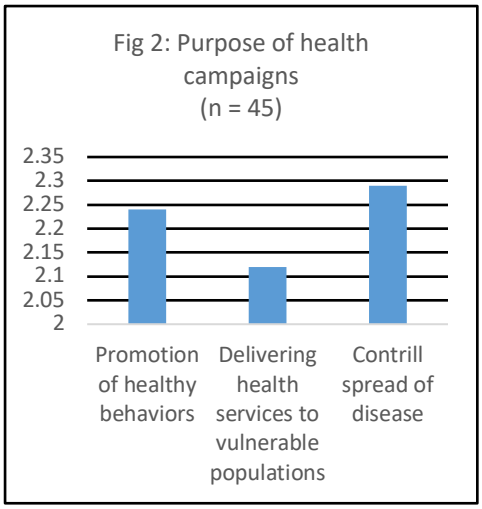
[3] This includes one meeting that had invited 120 people. The purpose of this meeting is present the health campaign plan and get a brough stakeholder buy-in of donors, mayors, district staff etc.

[4] We use poverty rates as a proxy of those who are most likely in need of health services, as there is significant amount of literature that show that there is a direct correlation between health and poverty and the fact that poor people are less likely to seek healthcare.

coverage rates for vitamin A and deworming compared to affluent districts (fig 1). The poorest district screened and found the highest level of oedema and severe malnutrition about 10 percent, compared to the other 29 districts which identified 1–2 percent cases.



The MOH's manual microplanning method did not analyze the relationship between coverage and poverty rates. An online survey of 45 of the estimated 51 health campaign planners revealed that respondents did not see providing health services to marginalized groups as a primary goal of health campaigns (fig 2).



Based on the analysis conducting using the predictive analytics tool, the machine learning could not identify the budget allocation rationale that the MOH used to dispense the funds to districts. The predictive analytics tool found that the districts with the least poverty rates (less than 20%) were allocated between US$2.64 to US$5.51 per person for the health campaign budget. On average the poorest district was allocated US$2.09 per person, an amount 20 - 62 percent less than all the other districts. The standard deviation across the 30 districts was $0.85. The budget dispensing strategy was also not depedent on the population of that district nor past district performance. The tool analysis also showed that those districts with poverty rates of 21% - 60% representing 80% of the population were allocated on average a USD 1.00 less per person than the richest districts[5]. The predictive analytics tool could not find any patterns or rationale between the budget allocation and the coverage rates attained. The current manual microplanning system did not conduct any analysis on resource allocation and vulnerable communities.

Table 2: The allocated price difference between middle quantiles and rich quintiles.

Poverty quintiles[6]	No. of districts	The operational budget allocated per person		Target Population	Target Pop (%)	Allocated Price Diff
		Low	High			
Richest - 5	4	$2.64	$5.51	280,751	17%	$2.87
4	9	$1.53	$3.68	519,012	31%	$2.15
3	16	$1.74	$3.23	818,116	49%	$1.50

[5] Richest quintile – the average price difference of quintile 3 and 4. (2.87- (average (2.15+1.50)

[6] Quintiles are based on per capita income. **The first quintile is the poorest 20%**, while the 5th quintile is the richest 20% (https://www.worldbank.org/en/topic/poverty/lac-equity-lab1/income-inequality/composition-by-quintile)

2	1	$2.09	$2.09	58,929	4%	
Poorest - 1	0					

The predictive analytics tool produces a series of key performance indicators. These indicators are mathematical calculations and may not necessarily represent the total reality of the program, but they provide rough estimations, baseline, and trends which will be further refined if the MOH continues to use the tool.

Indicator	**Integrated health Campaigns**		
	May 2022	**Oct 2019**	**May 2018**
Total operational campaign budget (excluding medical supplies	US$1,116,558	US$605,704	US$610,506
District implementation budget	61%	90%	82%
Central supervision budget	5%	5%	10%
Social mobilization budget	34%	5%	8%
Coverage rate for Vitamin A	93%	98%	
Coverage rate for deworming	97%	103%	92%
The aggregate coverage rate of the integrated health campaign including Vitamin A and deworming (adapted from perfect order KPI)	87%	106%	99%
Target population forecasting accuracy for Vitamin A and deworming	93%	83%	90%
Target population forecasting accuracy for nutrition	66%		

The direct observation of the tool used by 13 MOH health campaign staff showed that they were able to navigate the tool easily and found it intuitive. Very few questions were raised as they worked through the tool. An online survey after the direct observation was completed by 10 out of 13 people and provided the following

Table 2: User-feedback results

	User Feedback	**Response**
Context and Goals	Met intended goal	60% definitely, 40% probably

User-experience	Overall perception	20% extremely valuable, 80% very valuable,
User-interface	Organization of the tool and its appearance	80% yes, 20% don't know
Validation	Functionality – did the tool do what it proclaimed	100%
Verification	Has everything it needs	20% strongly agree, 40% agree, 30% neither agree nor disagree, 10% disagree
Interactive system	Appropriate hardware, software	Not sure
Features	Impressive features	90% allowed multiple people to work on it at the same time, 70% overview dashboard for decision-makers, 60% automation of forecasts and report generator

Promising Practices

The use of the predictive analytics digitization platform shows promise, and it is in alignment with the WHA's call to adopt and promote the use of digital health technology. Based on the information gathered through KII and FGD, the predictive analytics tool addresses the challenges of planning health campaigns, especially the ability to work on a single platform and have planning visibility across departments. The MOH is impressed enough with the tool to retest it for the upcoming October 2022 integrated health campaign.

The tool allows health campaign planners to generate numerous indicators to assess program performance. This same analysis can be conducted using Excel but take time and require significant manipulation of data. While most of the key performance indicators are an output of mathematical calculation, it still provides program insight that can be used to improve the planning for the next round. Examples of insight these indicators provide is to better understand clearer rationale for budget allocations or exploring why the social mobilization budget doubled compared to the last two years, or the fact that the target population forecast accuracy continues to be a challenge and a need to consider triangulation of population projections instead of using one source of data.

Lessons Learned

Early collaboration with the health campaigner planners is key to achieving the adoption of the technology. Building a tool that specifically addresses a health campaigner planners pain points is vital. In the case of Rwanda, the KII confirmed that long, arduous planning time, manual management of the data, and generation of final reports were considered the biggest pain points. While the donors and the tool development were more interested in finding the right client to target the health campaign

services, the MOH staff in Rwanda were more interested in the tools' potential of reducing staff workload and bringing transparent visibility into the planning process.

Most health campaign staff were reluctant to take on another digital tool, especially one that is built by a private sector company given the countries' experience with many failed digital systems. The team has taken steps to build this trust. This includes involving a local partner from day one in the design of the solution, offering an equal partnership in the expansion of the tool to other countries, and confirming that the country would have control of their data even though it would be stored in a cloud. But beyond these approaches, there is a need for a third-party arbitrator so that the MOH can seek impartial technical advice. This third-party needs to be technology agonistic but also with an eye towards innovation. Universities would be best placed to fulfill this role.

Any predictive analytics or AI tool needs more and more data for it to be able to learn and help improve planning efficiency and service targeting. This requires investment in continuous back-office support either through the building of in-house capacity or outsourcing it to a third party. A cost-benefit study to better understand the recurrent cost of maintaining this or any other digital product should be the next step in determining its adoption.

Implications for Policy, Practice, and Future Research

The use of predictive analytics could significantly improve health campaign planning. However, these tools require continuous maintenance and updates. Local capacity is key to its success. An untapped partnership to build this local talent is working with the local university and setting up internships and other department arrangements that would benefit student learning and fill a talent gap for the MOH. With the proliferation of tools, the Government of Rwanda also needs to consider its entire data management eco-system and determine how each of these tool's fits in its overall digitization strategy.

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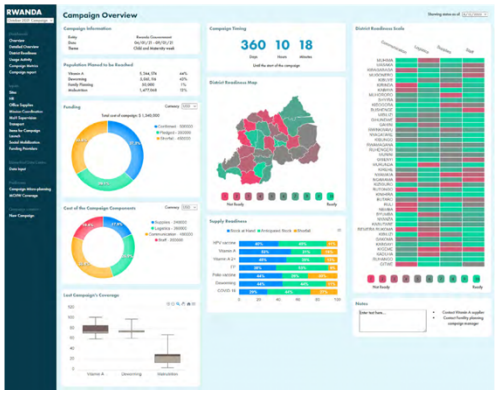
Annex 1: Health campaign predictive analytics tool

Overview Section

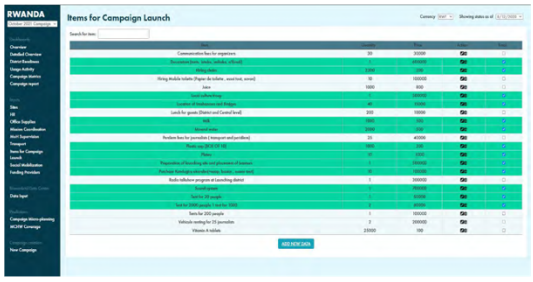
- New campaigns can be easily set up and planned on a regional or national level.
- The dashboard's overview section provides a summary of each campaign.
- This summary page provides the Campaign Planner with a simple comprehension of the activity and resources required for maximum effectiveness, at a regional level



Campaign Creation

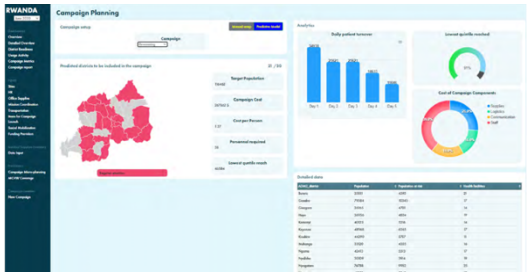
The user can set up unlimited campaigns using a simple, accessible, and intuitive creative process.

This process has pre-set parameters, allowing for the automatic adjustment and pre-population of data sets, minimizing the administration time required.



Input section

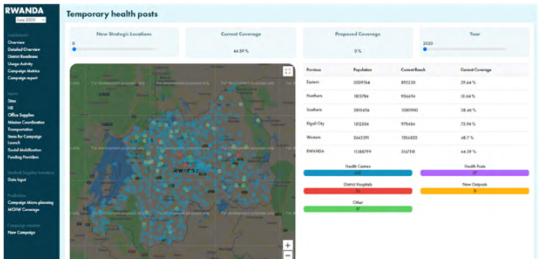
The dashboard allows for multiple users to work simultaneously, allowing for individual managers to set up, add, edit, and delete data sets relating specifically to their campaign.



Predictive analytics

Using predictive artificial intelligence models, the dashboard can identify geographic regions that may require additional resources. Additionally, the tool provides essential data on the total target population, cost of the campaign, cost per person, and lowest quantile reach.

Individual regions can also be selected, with the dashboard automatically adjusting its parameters as well as required resources on a regional basis.



Prediction of temporary health post locations

Importantly, the dashboard can predict the best strategic locations for mobile health posts for maximum patient reach and effectiveness, based on the campaign parameters.

Dashboard Summary

- Operates from the cloud, as well as offline
- Centralizes and streamlines data for ease of planning, tracking, and delivery of health campaigns
- Personalized overview pages, which are optimized for different stakeholders
- Predictive analytics that help identify regions requiring additional resources whilst calculating the cost of them
- Predictive analytics learns from past campaigns and becomes smarter after each deployment
- A highly secure system with authentication is required to access each section
- Can be used for planning campaigns lasting up to 5 years
- Beyond health, it can use to optimize logistics and delivery of educational campaigns.

Annex 2: Study Methods