

Full Length Research Paper

Co-creation of strategies and interventions to improve mobile-linked point-of-care diagnostics user experience in the South African Context: Nominal group technique

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User experiences are crucial for the sustainable development and implementation of mobile-linked point-of-care diagnostic technologies. The Nominal Group Technique (NGT) engages stakeholders to co-create strategies that improve the uptake of these technologies in community healthcare settings, particularly in disease-burdened and resource-limited contexts like South Africa. Stakeholders provide insights from social, economic, technological, and medical perspectives. The NGT was used at the REASSURED Diagnostics Symposium workshop, conducted in two phases: identifying potential barriers and developing strategies to address them. Data were collected via Google Forms and thematically analyzed, with themes ranked using a Likert scale from 1 (very low priority) to 7 (highest priority). Key challenges affecting user experiences included psychological issues, turnaround time, and connectivity. Top strategies to mitigate these challenges were health education and offline-capable technology. The NGT workshop facilitated the co-creation of practical strategies to enhance mobile-linked point-of-care diagnostics user experiences in South African healthcare settings.

Key words: Interventions, nominal group technique, point-of-care diagnostics, the South African context, user experiences.

INTRODUCTION

Point-of-care diagnostic tools are utilized in various healthcare settings to provide rapid and accurate diagnostic information at the point of patient care (Nayak et al., 2017). These tools are designed to be portable,

easy to use, and capable of delivering results quickly, enabling healthcare providers to make informed decisions promptly (Wang and Kricka, 2018). The current usage of point-of-care diagnostic tools involves their

deployment in diverse clinical settings, such as hospitals, clinics, emergency rooms, and remote or resource-limited environments (Heidt et al., 2020). These tools are employed for various applications, including infectious disease testing, cardiac biomarker analysis, pregnancy testing, and blood glucose monitoring (Park, 2021; Biswas et al., 2022). Mobile-linked point-of-care diagnostic tools have enabled efficient diagnosis and treatment of diseases in areas lacking advanced medical and laboratory infrastructure (Fu et al., 2024).

Advances in point-of-care diagnostic technologies, linked to mobile applications or devices, have led to assessments of user-friendliness, focusing on user experiences. The Food and Drug Administration (FDA) describes user-friendly point-of-care diagnostic technology as requiring minimal training and no user interpretation (Everitt et al., 2021). Ideally, end-users should be involved in developing mobile-linked point-of-care technologies to ensure the end product suits their needs, improving user experience (Nayak et al., 2019). User experience in health technologies refers to how users interact with and respond to the technology (Triberti and Brivio, 2020), considering the target community's expectations, personal objectives, and lived experiences (Pravettoni and Triberti, 2020). Sustainable implementation of point-of-care diagnostic technology requires trust from all stakeholders, including patients and medical personnel (Dhawan et al., 2015).

This study aims to co-create strategies and interventions to improve mobile-linked point-of-care diagnostics user experience in the South African context. Previous research identified key factors contributing to sustainable implementation, including regulatory and technological considerations, academic experts, patients, and frontline users (Wallis et al., 2017). Studies have shown that user perspectives on mobile-linked health technologies can be limited by misunderstandings of instructions (Farao et al., 2020) and the effectiveness of crowdsourcing methods in clinical practice (Sims et al., 2016). However, there is limited research on users' perspectives on mobile-linked point-of-care diagnostics, particularly in resource-limited South African healthcare settings.

User experiences are vital for the successful implementation of health technology, particularly mobile-linked point-of-care diagnostic technology. Positive user experiences are associated with tools that are intuitive, provide clear results, require minimal training, and fit seamlessly into existing workflows (King et al., 2016). Successful implementation is closely linked to user experience, leading to increased user acceptance (Onasanya et al., 2023), enhanced patient care outcomes, and integration into routine clinical practice

(Iqbal, 2017). The research question focuses on understanding and optimizing user experience for the successful implementation of mobile-linked point-of-care diagnostic tools in healthcare settings. The research problem lies in the lack of focus on end-user experience of medical diagnostic technologies, highlighting the need to design tools that meet the needs and preferences of healthcare providers. By doing so, manufacturers can facilitate adoption and utilization, ultimately improving patient care and clinical outcomes (Korte et al., 2020).

Key stakeholders can provide valuable insights from social, economic, technological, and medical perspectives to help develop strategies to improve the uptake of mobile-linked point-of-care diagnostic technologies (Ongaro et al., 2022). The co-creation of strategies through a collaborative process involving multiple stakeholders during a Nominal Group Technique (NGT) workshop can identify potential strategies. The interventions discussed target patients, healthcare workers, and developers, as all will be affected by the success or failure of implementing such healthcare interventions. The rationale is that these strategies would benefit healthcare workers and patients by improving community-based healthcare quality, which involves personalized, local-level healthcare services (Maraccini et al., 2017).

This study aimed to co-create strategies and interventions to improve mobile-linked point-of-care diagnostics user experience in the South African context using the Nominal Group Technique.

MATERIALS AND METHODS

The Nominal Group Technique (Frediani et al., 2021; Delbecq and Van de Ven, 1971) was employed to facilitate collaboration with key stakeholders who attended the REASSURED Diagnostics symposium, organized by the REASSURED-d@UP research group. The symposium took place on November 22-23, 2022, at Future Africa in Pretoria, under the theme "Post Covid-19 research trends." More information about the symposium is available via the provided link. The key stakeholders participating in the co-creation workshop included researchers, laboratory specialists, and academics (Supplementary material S1). The workshop aimed to identify potential challenges faced by point-of-care diagnostics users in the South African context and develop strategies to overcome these challenges. Stakeholders were defined as individuals with expert knowledge of point-of-care diagnostics technologies and their application in community-based healthcare, who have an interest in improving their implementation and use in the South African context of community healthcare systems.

Aims and objectives

The study aims to determine potential challenges faced by point-of-

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care diagnostics users in the South African context, as well as potential strategies to overcome these challenges. The objectives are as follows:

1. To determine the perspectives of key stakeholders regarding potential challenges faced by users of mobile-linked point-of-care diagnostics in the South African context.
2. For Key stakeholders to propose the most effective potential strategies that can be implemented to address the challenges identified in Objective 1.

Study participants and sampling

Key stakeholders were invited who attended the symposium to participate in the workshops.

Eligibility criteria

Inclusion criteria

Individuals will be included if they meet the following inclusion criteria:

1. Researchers and academics with experience in mobile-linked point-of-care diagnostic technology for communicable and non-communicable diseases.
2. Industry personnel involved in developing, manufacturing, and commercializing mobile-linked point-of-care diagnostic technology.
3. Academics or researchers whose research focuses on mobile-linked point-of-care diagnostic technology.
4. Individuals who can communicate in the English language.

Exclusion criteria

Exclusion criteria include:

1. Healthcare professionals not involved in using mobile-linked point-of-care diagnostic technology.
2. Individuals requiring consent from a legal guardian or parent to participate in the study.

Workshop program

The collaboration with key stakeholders aimed to determine the potential challenges that could be faced by mobile-linked point-of-care diagnostics users, as well as determine possible strategies that could help alleviate those potential challenges in the South African context. This was achieved through the Nominal Group Technique, which involved a group discussion where the problem was identified, solutions were formulated through discussions, and finally, decisions were made after reaching a consensus as a collective.

The workshop was conducted in two consecutive phases. Phase one focused on determining the potential challenges that mobile-linked point-of-care diagnostics users could face, while phase two aimed at determining the potential strategies that could be implemented to alleviate these challenges and setbacks identified in phase one.

Phase 1: Participants were asked to share their perspectives regarding potential challenges faced by users of mobile-linked point-of-care diagnostics in the South African context within their

discussion groups. Each participant had a sticky note to jot down their ideas before discussing them with group members. The ideas were then placed on a chart for thematic analysis. Once everyone in the group agreed, the facilitator (TPM-T) listed the emerging themes in a voting form/questionnaire to enable voting through ranking using a Google form (Supplementary information S2). Participants were requested to rank the themes according to the level of severity of potential challenges that could be faced when using mobile-linked point-of-care diagnostics. The ranking score was between 1 and 7, with 1 being the least severe and 7 being the most severe challenge.

Phase 2: Key stakeholders were requested to propose the most effective potential strategies that could be implemented to address the challenges identified in Phase 1 and group them according to themes, as done in Phase 1 for the challenges. The PI listed the themes in a voting form/questionnaire to enable voting through ranking using a Google form. Participants were requested to rank the themes according to the level of effectiveness in alleviating the challenges that could potentially be faced by mobile-linked point-of-care diagnostic users. The ranking score was between 1 and 7, with 1 being the least effective and 7 being the most effective strategy.

Once the Nominal Group Technique workshop was concluded, the results obtained from the Nominal Group Technique were compiled by SRN in the form of a report and shared with key stakeholders for comments.

Data management and analysis

The ranking of themes was guided by a Likert scale, where participants ranked themes from least to most important based on their knowledge and expertise. Quantitative data analysis involved calculating total importance scores for each potential challenge (Phase 1) and strategy (Phase 2) by summing individual participant scores. The ranking scores ranged from 1 (least severe challenge/least effective strategy) to 7 (most severe challenge/most effective strategy). Thematic content analysis was used to analyze qualitative data, identifying emerging themes from discussions.

RESULTS

Twelve experts representing different population groups participated in the Nominal Group Technique workshop (Supplementary material S1). The participants comprised 50% women, with 58.3% (7) employed and 41.7% (5) students. Stakeholders identified 18 potential challenges affecting users' experiences of mobile-linked point-of-care diagnostics in the South African context (Figure 1). The challenges were ranked according to total voting scores. The top challenges included connectivity, psychological issues (the effect of the test outcome on the mental health or state of the patient), and turnaround time. The least important challenges included lack of access to devices, software updates, and poor image quality. Stakeholders were then asked to suggest potential strategies to overcome these challenges. Seven of the 12 stakeholders responded to the follow-up questions. Due to tied rankings, stakeholders agreed to focus on connectivity, psychological issues, and turnaround times

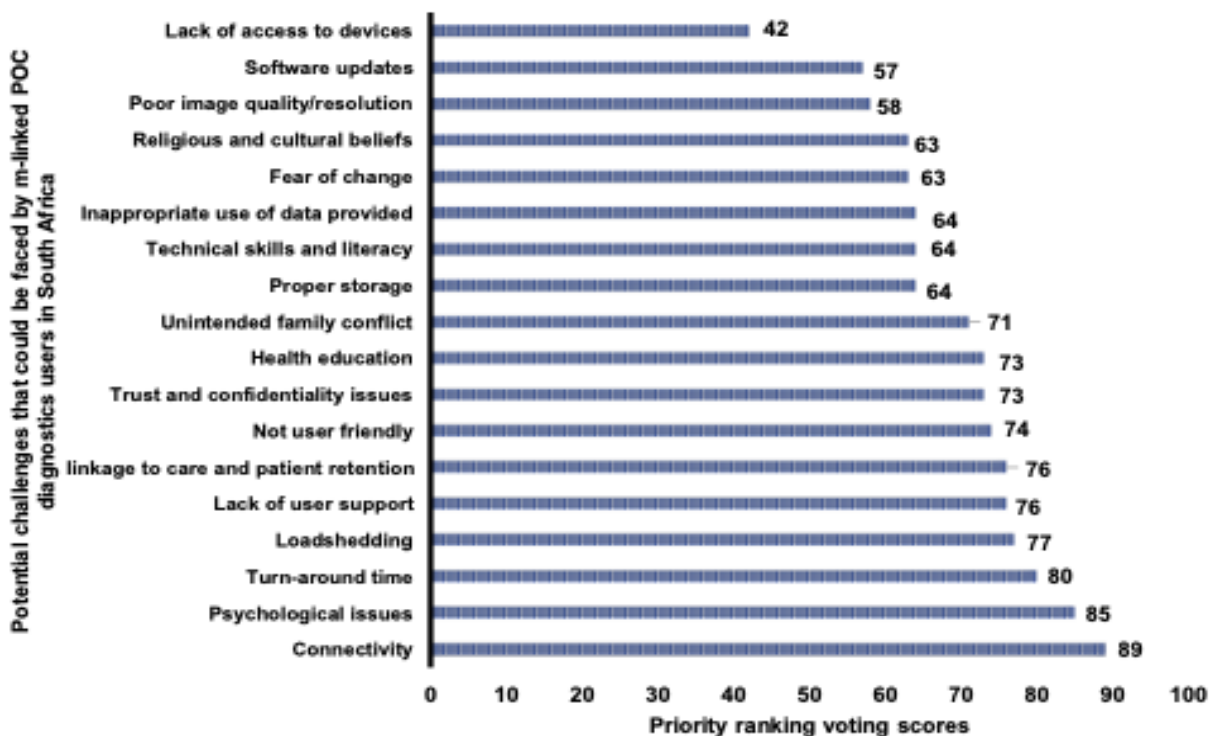


Figure 1. Voting scores for potential challenges that could affect user experiences of mobile-linked point-of-care diagnostics.

Table 1. Potential strategies to overcome connectivity issues.

Recommended strategy	Summing by votes [1=less effective, 7=highly effective]							The sum of voting scores	Percentage importance
	1	2	3	4	5	6	7		
Ability to function offline						1	6	48	98
Built-in counseling					2	0	5	45	92
Decentralization of information technology					3	1	3	42	86
Community sensitization					3	2	2	41	84
Improved infrastructure			1		1		5	40	82
Zero-rated services					2	2	2	36	73
Family support			1	1	3	1	1	31	63

as the challenges to analyze further.

Potential strategies to improve user experiences of mobile-linked point-of-care diagnostics in the South African Context

Potential strategies to overcome connectivity challenges

Stakeholders suggested strategies to overcome connectivity issues (Table 1) including that devices should be able to function offline (98%), built-in counseling (92%), and decentralization of information

technology services (86%). Stakeholders agreed that family support (63%), zero-rated services (73%), and community sensitization (84%) were unlikely to overcome connectivity challenges.

Potential strategies to overcome psychological challenges

Regarding overcoming psychological challenges, stakeholders agreed that health education (96%) and post-test counseling (96%) could be implemented as strategies to overcome these challenges (Table 2). Stakeholders agreed that system functionality (80%)

Table 2. Potential strategies to overcome psychological challenges.

Recommended strategies	Summing by votes							The sum of voting scores	Percentage importance
	[1 = less effective, 7 = highly effective]								
	1	2	3	4	5	6	7		
								49	100
Post-test counseling						2	5	47	96
Health education					1		6	47	96
Advocacy					1	2	4	45	92
System functions				1	3	1	2	39	80

Table 3. Potential strategies to improve the turnaround time.

Recommended strategies	Summing by votes							The sum of voting scores	Percentage importance
	[1 = less effective, 7 = highly effective]								
	1	2	3	4	5	6	7		
								49	100
Education on the test process					1	0	6	47	96
Stable connectivity					1	0	6	47	96
Up-to-date software					1	1	5	46	94
Alarm system				1	0	2	4	44	90
Health education				1	1	1	4	43	88
Flexibility on choices				1	2	1	3	41	84
User orientation or awareness				1	2	2	2	40	82

would be unlikely to overcome psychological challenges.

Potential strategies for overcoming turnaround time challenges

Stakeholders recommended strategies to improve turnaround time (Table 3), including education on the test process stable connectivity (96%th flexibility on choices (84%), and user orientation or awareness (82%), which was ranked as potentially the least effective strategy.

Stakeholder feedback

All 12 key stakeholders who participated in the workshop were asked to comment on the suggested strategies for improving user experiences of mobile-linked point-of-care diagnostics in community-based healthcare in the South African context. All participants received and read the report; however, only three participants provided additional suggestions on the implementation of the suggested strategies focusing on health education and the ability to function offline. Their suggestions are presented in Table 4.

DISCUSSION

This Nominal Group Technique workshop allowed for an

in-depth collaborative discussion between key stakeholders to identify potential challenges that may affect user experiences of point-of-care diagnostics in the South African context. These discussions also revealed potential strategies that could improve user experiences. In sub-Saharan Africa, mobile phone connections are estimated to reach 55% by 2020 (Wood et al., 2019). With this increase in digitization, connectivity was identified as an important potential challenge for user experiences of point-of-care technology. The study aims to identify potential challenges faced by point-of-care diagnostics users in the South African context, as well as potential strategies to overcome these challenges. Connectivity, psychological issues, and turnaround times were identified as the most important challenges needing to be addressed. The suggested strategies to address these challenges are discussed in this section.

Overcoming connectivity issues of point-of-care diagnostics

Point-of-care diagnostic tools can be linked to mobile devices for remote diagnosis, analysis, and communication between healthcare professionals (Roess, 2017). However, connectivity problems may lead to data entry errors, data loss, and user disengagement due to poor user experience. To address connectivity challenges, stakeholders suggested that devices should function offline and that information technology services

Table 4. Additional suggestions on the implementation of the suggested strategies provided by participants for improving user experiences of point-of-care diagnostics in the South African context.

Strategy	Key stakeholder perspectives
	Use audio and visual aids to increase the patient's understanding of the health issue; Use interactive activities to keep users engaged throughout the learning process.
Health education	Health education on the turn-around time associated with the POC diagnostics will reduce the doubt associated with the results from the tests; Health education will assist healthcare workers and patients in handling psychological issues associated with results obtained for m-linked POC diagnostics. Less depression, suicides, and resistance to treatment will be observed.
	Mobile app must come with a clear manual on the testing procedure; Educate user on testing procedure, how to avoid delays, and how to capture results and all other necessary data.
	Develop an app that can work without a network or data; The app will need an internet connection to download and synchronize the data but once this process is done, it can be used offline.
Ability to function offline	Ability to function offline is helpful in resource-limited settings where patients do not have the financial means to purchase the mobile data required for using m-health apps. Creating offline options in this area is an important way of making healthcare more accessible to all members of the population
	The ability of POC diagnostics to function offline is vital. This allows for countries that have serious challenges with electricity to still maintain the mandate of improving the quality of public health. Patients will still be able to utilize these devices and subsequently obtain the correct treatment.

should be decentralized, providing open network access (Levy, 2011; Zarrin et al., 2021). This would enable access to previously inaccessible internet services (Zarrin et al., 2021) and connect millions of devices in an open network (Uddin et al., 2021). In areas with poor infrastructure, offline-capable mobile applications used with point-of-care diagnostic technologies would reduce disconnection risks and keep users engaged. These suggestions are supported by reports on the failure rates of tuberculosis diagnostic devices due to unpredictable power supply issues (Raizada et al., 2014; Creswell et al., 2014), a challenge relevant to the South African context where network coverage is often affected.

Overcoming psychological issues in the acceptance and user experience of point-of-care diagnostics

Key stakeholders noted that patients' psychological issues, such as fear of results, may impact their user experiences and acceptance of point-of-care diagnostics. Research by Genoway et al. (2016) supports this, showing that patients who tested positive for HIV via point-of-care testing had negative experiences due to inadequate information about the testing process and potential impact of results. Additionally, post-testing counseling was often neglected. Stakeholders suggested that health education and post-test counseling could alleviate psychological challenges, particularly for patients receiving undesirable results. Patients should be

educated about the purpose of diagnostic tests and potential outcomes. Mandatory post-test counseling would guide patients on health care and treatment options.

This view is shared by healthcare workers in community-based settings, who highlight challenges such as lack of private counseling spaces and need for training and education (McKeirnan et al., 2021). The South African mobile HIV program, which incorporates counseling into point-of-care testing, is an example of a model that could mitigate negative psychological responses (Larson et al., 2012). Healthcare services should provide a safe and equipped space to support patients, especially those with undesirable test outcomes.

Improving turnaround time in the implementation of point-of-care diagnostics

Turnaround time, the duration from testing to analysis to diagnosis, is a crucial challenge for user experiences of point-of-care diagnostic technologies. Ideally, these technologies should reduce the time taken to make informed decisions on patient management and care (Pecoraro et al., 2014). To ensure a short turnaround time and optimal user experience, users need to understand the test process, have stable connectivity, and flexibility in choices. Educating end-users on point-of-care technologies would facilitate ease of use and shorten the testing process. Stable connectivity is also

essential, as poor connectivity can prolong turnaround time.

Additionally, end-users should have flexibility in choosing the most effective point-of-care diagnostic technology for their setting, allowing for an optimal testing process. This includes deciding how diagnostic results and medical data are processed and stored.

Strengths and limitations

The study's strength lies in the use of the Nominal Group Technique to co-create strategies for improving user experiences of point-of-care diagnostics through collaborative discussion among key stakeholders. This technique helps limit bias by ranking ideas and preventing any participant from dominating the discussion.

This study has several limitations. Firstly, end-users of point-of-care diagnostics, such as patients and healthcare workers, were not included to share their challenges and suggest strategies. Secondly, group discussions may have influenced individual participants' ideas. Lastly, the study did not focus on specific point-of-care diagnostic tools, resulting in general observations rather than tool- or disease-specific insights.

Conclusions

Key stakeholders collaborated in a Nominal Group Technique workshop, identifying crucial challenges to user experiences of point-of-care diagnostics and co-creating strategies to overcome these challenges in the South African context. This approach adequately addressed the research question. The study's findings highlight the importance of health education and stable connectivity in ensuring optimal user experiences of mobile-linked point-of-care diagnostic technologies. Improving these aspects can enhance healthcare infrastructure, particularly in underserved communities, ultimately improving quality of life. Future research should focus on specific mobile-linked point-of-care diagnostic tools used in the South African context and involve more healthcare workers and patients to gain deeper insights and develop targeted solutions.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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