Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

MotivAid: A digital health solution to enhance evidence based prevention and management of postpartum hemorrhage using the E-MOTIVE bundle

Aisha Baffa Abubakar
aishabaffaabubakar@gmail.com

capital City University, Kano, Nigeria

Abdulrashid Idris
Bayero University Kano

Amina Suleiman Rajah
Bayero University Kano

Abdulhalim M. Yaro
kano Digital Innovation Network, Nigeria

Halima H. Bello
Accord Surgery Specialist Hospital, Kano

Munir Ammani
Health Tech Innovators Forum

Abdulrahman Babatunde
Health Tech Innovators Forum

Bilkisu H. Bello
Health Tech Innovators Forum

Research Article

Keywords: Artificial Intelligence, Digital Health, E-MOTIVE, Postpartum Hemorrhage

Posted Date: September 16th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10667049/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Introduction:

Postpartum hemorrhage (PPH) remains a leading cause of maternal morbidity and mortality worldwide. Although the E-MOTIVE bundle has proven effective in improving early detection and management, gaps persist due to challenges in delays, errors in bundle application, inadequate fast tool for blood loss estimation and lack of real-time clinical support device, increasing the risk of preventable maternal deaths.

Aim

To develop& pilot test MotivAid, a digital health application that supports midwives in applying the E-MOTIVE bundle for the prevention and management of postpartum hemorrhage guided by the triple helix model of innovation.

Methods

A user-centered developmental design guided by the triple helix model of innovation was used, frontend was built with React Native and TypeScript, while backend used Supabase and PostgreSQL for secure, real-time data management. The app integrates AI-driven blood loss estimation (ResNet50). A pilot with 17 midwives in Kano, Nigeria provided a qualitative feedback.

Results

The development process resulted in a functional prototype of MotivAid, The application features AI-driven blood loss estimation, automatic shock index calculation, automated alerts, offline functionality, and voice-assisted clinical steps &input, dual mode both clinical and simulation training and prompt documentation. Pilot testing with 17 midwives showed the app is user-friendly, saves time, Improves efficiency and increases adherence to the Emotive bundle, feedback highlighted usability, effectiveness and potential for broader adoption.

Conclusion

MotivAid translate evidence-based guidelines into practical clinical digital tool. The innovation addresses critical gaps in PPH management and offers strong potential for commercialization, large-scale implementation, and sustainable improvement on maternal health outcomes.

Introduction

Postpartum hemorrhage (PPH) remains the leading cause of maternal mortality worldwide, accounting for approximately 13.4% of all maternal deaths [1]. Globally, PPH complicates 1%–10% of all births, resulting in over 14 million cases and about 140,000 deaths annually [2], which translates to roughly one maternal death every four minutes. The burden is disproportionately higher in low- and middle-income countries, particularly in sub-Saharan Africa and South Asia, where PPH contributes to 25%–43% of maternal deaths, compared to much lower proportions in high-income countries [3, 4].

The causes of PPH include uterine atony, genital tract trauma, retained tissue, and thrombotic disorders. Most cases, however, occur without identifiable risk factors, emphasizing the need to treat every woman as a potential PPH case to reduce morbidity and mortality [5]. In Nigeria, PPH accounts for a substantial proportion of maternal deaths, with prevalence rates ranging from 0.4% to 16.8%, and some regions reporting up to 42% of maternal deaths [6]. Notably, Kano State has consistently recorded the highest prevalence of primary PPH in the country, estimated at 2.45% to 6.35%, with uterine atony responsible for over 50% of cases, and prolonged labor or previous PPH history as key risk factors [7].

Mobile health (mHealth) technologies offer promising solutions to bridge gaps in maternal care. Defined as the use of mobile devices and network technologies in collecting, delivering, and accessing health information, mHealth supports professionals, researchers, and patients alike [8, 9]. These tools enhance quality and efficiency in healthcare delivery, providing decision support, reminders, and structured workflows that reinforce clinical guidelines [10].

Despite the availability of evidence-based interventions, timely detection and management of PPH remain a major challenge. Every six minutes, a mother dies from PPH in low-resource settings, leaving behind young families, with infants having less than a 20% chance of surviving the first month [11]. The E-MOTIVE bundle, comprising; Early identification, Massage uterus, Oxytocin, Tranexamic acid, IV fluids, Vital sign monitoring, and Escalation/examination, represents WHO's first consolidated framework for early detection and response to PPH[10] (Acephap, 2023). Yet, there is delays, errors in bundle application, inadequate fast tool for blood loss estimation and lack of real-time clinical support device, increasing the risk of preventable maternal deaths.

To address these challenges, MotivAid, a mobile health solution tailored for midwives, is proposed to provide real-time clinical support and facilitate timely application of the E-MOTIVE approach, MotivAid bridges the gap between knowledge and practice. The tool empowers midwives to deliver rapid, evidence-based responses to PPH, ultimately reducing maternal mortality and advancing Sustainable Development Goals 3 and 9 (Good Health and Well-Being; Industry, Innovation, and Infrastructure) in resource-limited settings.

Objectives

To develop& pilot test MotivAid, a digital health application that supports midwives in applying the E-MOTIVE bundle for the prevention and management of postpartum hemorrhage guided by the **triple**

helix model of innovation

Theoretical Framework Underpinning the project Innovation

The triple helix model developed by Etzkowitz Henry and Loet Leydesdorff in 1990s[12] is a conceptual framework describing how academia (universities), industry (businesses)and government can work together to promote innovation, economic growth and social development through leveraging the strength and weaknesses of each sector, the model aims to create an environment where knowledge flows freely, research findings translate in to real world solutions, and policies support sustainable advancement[12].

Application;

The application of the triple helix model of innovation as a theoretical framework is presented in Fig. 1 below;

The sketch from Fig. 1 above shows how **MotivAid** project interact with each sector; **Academia** ensures the app is scientifically valid, clinically relevant and ethically sound. **Tech industry** transforms the research and clinical knowledge in to a functional, usable and scalable digital tool. **Government** provides legitimacy, resources and a pathway for system-wide adoption.

Methodology

This project adopts a developmental -methods design, involving a Collaboration with midwives, obstetricians, and ICT specialists to ensure user-centered features in alignment with the triple helix model of innovation. The app development involved an iterative process of design, testing and refinement with inputs from key stakeholders in the health sectors, academia and technology industry.

The app is developed as a lightweight cross app comprising of both a web and a mobile app using a modular architecture built using React Native and **TypeScript** for frontend development, ensuring the app's compatibility across both IOS & android phones and offline mode function even in areas with unreliable internet access. The backend was powered by **Supabase**, an open-source platform, which facilitated real-time data synchronization allowing midwives and other frontline workers in labor room to access patent information reliably during emergencies and database management using PostgreSQL. A central innovation of MotivAid is its AI-driven blood loss estimation, powered by a **ResNet50** deep learning model. The model was trained on a curated dataset of blood images, each carefully annotated using a comprehensive labeling schema that included blood volume (mL), surface type (pad, gauze, floor, clothes and lines), lighting conditions (daylight, fluorescent, or LED), clot presence, and capture distance. Images were pre-processed to standardize size, color balance, and lighting, and augmented using rotation, flipping, and contrast adjustments to enhance generalization.

The dataset was divided into training (70%), validation (15%), and testing (15%) subsets. The model was trained to minimize the mean squared error between predicted and actual blood loss, with hyperparameters optimized on the validation set. On the test set, the model achieved an accuracy of approximately 86% and a sensitivity of 89% for detecting excessive hemorrhage (≥ 500 mL), with a mean absolute error of ± 55 mL.

Following development, a pilot study with purpose of obtaining formative feedback rather than evidence of clinical effectiveness, was conducted involving 17 midwives and healthcare practitioners trained in the E-MOTIVE bundle, recruited from maternity facilities in Kano metropolis. Purposive sampling ensured that participants had prior exposure to the bundle and could provide informed, contextually relevant feedback. Recruitment was facilitated through professional networks, and all participants provided verbal informed consent.

Data collection involved semi-structured interviews, each lasting approximately 30–35 minutes, conducted primarily in-person at participants' facilities, the interview guide used in this study was developed by the research team specifically for obtaining feedback evaluation on the use of MotivAid Digital Health Solution. The questions were designed based on the study objectives, the E-MOTIVE bundle components, and relevant digital health usability and acceptability domains. The interview guide has not been previously published elsewhere. The English version of the interview guide is provided as supplementary file 1. All interviews were vedio-recorded with participants' consent, and detailed field notes captured contextual observations and non-verbal cues, providing additional depth to the qualitative data.

The collected data were analyzed using thematic analysis, following an iterative approach. Transcripts were read to identify significant statements, which were subsequently coded and grouped into broader themes, including usability, time efficiency, confidence and competency, impact on patient outcomes, barriers to use, and suggestions for improvement. Themes were refined iteratively to ensure they accurately reflected participant perspectives, and member checking was conducted to validate interpretations and further enhanced the trustworthiness and credibility of the findings.

Ethical approval

for pilot testing was obtained from the Kano State Ministry of Health Research Ethics Committee (Approval No: NHREC/17/03//2018/SHREC/2026/7670). Institutional permissions were secured from all participating hospitals. Data confidentiality was ensured through de-identification, password-protected storage, and restricted access of the app. The study complied with the Declaration of Helsinki (2013 revision).

Results

MotivAid development and pilot study featured a unique selling point.

The feature, description and the clinical relevance of the MotivAid obtain from the development process are presented in Table 1

Table 1
The Value Preposition of MotivAid

FEATURES	DESCRIPTION	CLINICAL RELEVANCE
AI-assisted blood loss estimation	ResNet50 model for real-time blood loss estimation from images of the delivery process	Reduced human error in blood loss estimation and drapes error in calibration and cost,speed emergency decision making
Automatic shock index calculation &alert	Calculate shock index and alert if there is danger, also send notification on call obstetrician and referral centers when dangers theresholds are met.	Enhance emergency action and improve communication and coordination.
Smart voice features	Speech-to text vital entry for blood pressure and pulse, hands free step by step guidance via voice over and timers.	Allows hands-free operations in high-stress labor environment.
Context-specific	customizable to E-MOTIVE guidelines	Reinforces adherence to evidence-based practices.
Offline-capable	Works in low-connectivity areas without requiring internet connections	Promotes tech utilization without interruption in low-connectivity areas.
Dual-mode	clinical + simulation training in order to allow both practitioners and students to simulate PPH cases and practice using the app.	Increase competency, confidence and familiarity. hence reduce error and delays
Prompt documentation	Generates audit reports for maternal death reviews and facility-level monitoring.	Reducing practitioner and administrative and support quality improvement.
Navigation tool AI	Uses GPS/ location services to find, access, and use information or move through the digital platform	Reduce delay in finding the right facilities and right healthcare providers closeby

All clinical content was developed based on WHO and ACEPHAP recommendations for PPH prevention, diagnosis and management using the emotive bundles, ensuring alignment with current evidence based practice.

The qualitative feedback obtained from the pilot studies are presented below in Table 2

Table 2
Qualitative feedback review

Theme	Findings	Quote From Health practitioners
Usability	Midwives found the app easy to navigate and appreciated its simple, user-friendly design.	“The app is very easy to use. The interface is clean, I didn’t struggle to figure it out even when things are hectic in the labor room.
Time Efficiency	Health practitioners reported that the app reduces the time spent administering the bundle, thanks to its reminders and prompt action for the step-by-step guidance	“we don’t waste time figuring out what to do nest, the reminders and alert helped us stay on track”
Confidence/Competency	Health practitioners reveal more competent and confidence in applying the bundle correctly especially during emergencies.	“I am now more sure of myself, especially when the app guides me” Respondent 3
Impact On Patient Outcomes	Health practitioners believes that the app could improve maternal outcomes	“I think the app could save lives, it help us act uickly especially when ther is no time to think deeply about each step” Respondent 7
Barriers And Challenges	Health practitioners encountered device compatibility issue, reveal training on the app’s features	“my phone cant download the app, I only access via the web app and I have to use the internet connection” Respondent 13
Suggestion For Improvement	Health practitioners suggest increasing the volume of voice prompts for noisy delivery room and adding multi lingual support for the training mode	“it could be helpful to have the voice prompts louder” “the app would be great in more languages so that every Health practitioners could use it comfortably” Respondent 5

The pilot findings are mainly interpreted as formative feedback rather than evidence of clinical effectiveness.

Discussion

Guided by **triple helix model of innovation**; MotivAid was designed as a structured, workflow-driven digital health tool that aligns with the time-critical nature of postpartum hemorrhage (PPH) management, particularly the recommended 15-minute response window emphasized in the E-MOTIVE approach. The application begins with a secure login interface, ensuring controlled access for authorized health workers and supporting accountability and data integrity, which are key principles in digital health governance [13].

The patient biodata module captures essential obstetric and clinical information, with automated flagging of high-risk women based on known PPH risk factors such as grand multiparity, prolonged labor, anemia, or previous PPH. Early identification of high-risk patients is critical for preparedness and prevention, and digital risk stratification has been shown to improve anticipatory care in maternal health settings [14].

For prevention, Motivaid embeds the E-MOTIVE preventive bundle, guiding frontline health workers through immediate actions within the first 15 minutes after birth. This structured delivery supports adherence to evidence-based practice during high-pressure clinical moments, where deviations from protocols commonly occur [15]. The mobile application with AI integration in MotivAid for blood loss estimation is consistent with the findings of Osei & Mashamba[16], which discuss the challenges of applying deep learning models in clinical environments. Similarly, Labrique et al [17], emphasize the importance of offline functionality in mHealth tools, particularly in resource-limited settings where internet access is unreliable. MotivAid successfully implements these findings, ensuring usability even in areas with poor connectivity.

The diagnostic platform applies the internationally recognized “4 Ts” framework (Tone, Tissue, Trauma, and Thrombin) to assist users in systematically identifying the underlying cause of PPH. Decision-support tools that standardize diagnostic reasoning have been shown to reduce delays and improve clinical accuracy in obstetric emergencies [18].

Once PPH is identified, the management module activates, providing step-by-step guidance aligned with E-MOTIVE management recommendations, emphasizing completion of critical interventions within the 15-minute emergency window. This real-time clinical support aims to reduce variability in care and support task prioritization, particularly in low-resource facilities with limited specialist availability [17].

To strengthen escalation of care, MotivAid incorporates an API-based emergency alert system that notifies on-call doctors or referral facilities when predefined danger thresholds are reached. Digital alert mechanisms have been shown to improve communication, reduce response time, and enhance coordination during obstetric emergencies [14].

Additionally, the app includes a voice-over reminder function, providing audible prompts for time-sensitive actions. This feature is particularly relevant in busy delivery rooms and low-literacy or high-stress environments, where visual prompts alone may be insufficient. Audio-based reminders have been associated with improved compliance to clinical protocols and reduced omission errors [13].

Collectively, these features position MotivAid not merely as an informational tool, but as an interactive clinical companion that integrates prevention, diagnosis, management, and escalation of postpartum hemorrhage care. While empirical evaluation is pending, the system architecture reflects best practices in digital maternal health design and addresses key behavioral and system-level barriers to timely PPH care.

The integration of clinical evidence from maternal health research aligns with existing studies, such as those by Agarwal et al. [14], which highlight the effectiveness of clinical decision support systems in improving maternal care. MotivAid builds on this by embedding real-time, evidence-backed interventions into the app, ensuring that healthcare practitioners can adhere to best practices in managing PPH

MotivAid's compliance with local health regulations on privacy policy like the Nigeria Data Protection Act 2023(NDPA) and Nigeria data protection regulation 2019(NDPR), copyright ownership from the Nigeria Copyright Commissions aligns with global best practices in digital health. Research by WHO [13], emphasizes the importance of regulatory compliance in mHealth tools, ensuring the protection of sensitive health data. This alignment ensures that MotivAid adheres to both local and international standards.

Limitations:

Although the AI-driven blood loss estimation was accurate, variations in image quality and clinical settings may affect the model's performance, particularly in low-resource environments. The pilot evaluation involved only 17 healthcare practitioners from Kano metropolis hospitals, which limits the generalizability of findings. Further research is needed to assess the app's performance in diverse healthcare environments. While the pilot phase showed promising results, the adoption of digital health tools can be challenging in areas where technological literacy is low, and further training may be necessary. MotivAid's scalability to a larger population requires addressing challenges related to system integration and ensuring widespread adoption across different healthcare systems.

Conclusion and Recommendation

MotivAid translates evidence-based guidelines into practical clinical digital tool. The innovation addresses critical gaps in PPH management and offers strong potential for commercialization, large-scale implementation, and sustainable improvement on maternal health outcomes. To scale MotivAid's, the next steps involve expanding the pilot study for early adoption phase validation. We recommend forming strategic partnership with government health agencies to ensure alignment with national maternal health priorities, and subsequently integration in to the hospital management system to enhance its adoption.

Abbreviations

- E-MOTIVE: Early identification, Massage uterus, Oxytocin, Tranexamic acid, IV fluids, Vital sign monitoring, and Escalation/examination
- PPH: Postpartum haemorrhage
- WHO: World Health Organization
- AI: Artificial Intelligence
- ML: Machine Learning

- ResNet50: Residual Network 50
- mHealth: Mobile Health
- API: Application Programming Interface
- UI: User Interface
- UX: User Experience
- IoT: Internet of Things
- Supabase: An open-source backend-as-a-service platform providing database, authentication, and storage services
- React Native: A cross-platform mobile application development framework
- LMICs: Low- and middle-income countries

Declarations

Ethics approval and consent to participate: Ethical approval for pilot testing was obtained from the **Kano State Ministry of Health Research Ethics Committee** (Approval No: **NHREC/17/03//2018/SHREC/2026/7670**). Institutional permissions were secured from all participating hospitals. Data confidentiality was ensured through de-identification, password-protected storage, and restricted access of the app. The study complied with the **Declaration of Helsinki (2013 revision).**

Consent for publication: Not applicable. This manuscript does not contain identifiable personal data, images, or information requiring consent for publication.

Availability of data and materials: The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request. Due to ethical considerations and the need to protect participant confidentiality, raw interview transcripts and related qualitative data are not publicly available. However, anonymised data may be shared upon reasonable request and subject to appropriate ethical approval.

Competing interests: The authors declare that they have no competing interests.

Funding: This research was supported by startup funding from ***Nigerian Youth Academy*** (NiYA). The funder provided financial support for the development of the project but had no role in the study design, pilot implementation or decision to publish the manuscript.

Authors' contributions: Author 1 contributed to the conception and design of the study. All authors contributed to the development of the MotivAid digital health solution, literature review, data collection, analysis, interpretation of findings, and manuscript preparation. All authors critically reviewed the manuscript, approved the final version, and agreed to be accountable for all aspects of the work.

Acknowledgements: The authors acknowledge the healthcare professionals at Unguwa Uku PHC, Accord Surgery Specialist hospitals and Primary Healthcare Management Board, maternal health experts, software developers, and all participants who contributed their time, expertise, and valuable insights during the development and evaluation of the MotivAid digital health solution. The authors also acknowledge NiYA for providing startup funding support that facilitated the development of this innovation.

References

1. World Health Organization, UNICEF, United Nations Population Fund (UNFPA), World Bank Group, United Nations Department of Economic and Social Affairs Population Division. Trends in maternal mortality 2000 to 2020: estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division. Geneva: World Health Organization; 2023.
2. Bláha J, Bartošová T. Epidemiology and definition of postpartum haemorrhage worldwide. Best Pract Res Clin Anaesthesiol. 2022;36(3-4):325-339.
3. World Health Organization. Second global call for data on postpartum haemorrhage [Internet]. Geneva: World Health Organization; 2024. Available from: https://www.who.int/newsroom/articles/detail/second-global-call-for-data-on-postpartum-haemorrhage
4. Schlembach D, Malel ZJ, Begum F, Nunes I, Ubom AE, Muslim Z, et al.; FIGO Childbirth and PPH Committee. Postpartum hemorrhage: findings of a global survey by the World Association of Trainees in Obstetrics and Gynecology (WATOG). J Glob Obstet. 2025;70512. doi:10.1002/jgo.70512.
5. Adebayo T, Adefemi A, Adewumi I, Akinajo O, Akinkunmi B, Awonuga D, et al. Burden and outcomes of postpartum haemorrhage in Nigerian referral-level hospitals. BJOG. 2024;131(Suppl 3):64-77. doi:10.1111/1471-0528.17822.
6. Federal Ministry of Health (FMOH). National guidelines for the management of postpartum hemorrhage (PPH). Abuja: Federal Ministry of Health; 2025.
7. Wakili AA, Aswat A, Timms R, Beeson L, Mammoliti KM, Devall A, et al. Differences in obstetric practices and outcomes of postpartum hemorrhage across Nigerian health facilities. Int J Gynaecol Obstet. 2022;158(1):142-150. doi:10.1002/ijgo.14198.
8. Fundación Telefónica. La sociedad de la información en España 2016 [Internet]. 2016. Available from: https://www.fundaciontelefonica.com/cultura-digital/publicaciones/la-sociedad-de-la-informacion-en-espana-2016/558/
9. Gazdecki A. 9 mobile technology trends for 2017 (infographic) [Internet]. BiznessApps; 2017. Available from: https://www.biznessapps.com/blog/mobile-technology-trends/
10. Martinez-Millana A, Jarones E, Fernandez-Llatas C, Hartvigsen G, Traver V. App features for type 1 diabetes support and patient empowerment: systematic literature review and benchmark comparison. JMIR Mhealth Uhealth. 2018;6(11):e12237. doi:10.2196/12237.

11. Africa Centre of Excellence for Population Health and Policy (ACEPHAP). E-MOTIVE Trial: early detection and treatment of postpartum haemorrhage [Internet]. Kano: Bayero University Kano; 2023. Available from: https://acephap.buk.edu.ng/emotive-trial
12. Sultan S. Enhancing the value chain of medical and aromatic plants in Palestine using the triple helix model. Int J Innov Stud. 2020;4(2):1611-1623.
13. World Health Organization. WHO guideline: recommendations on digital interventions for health system strengthening. Geneva: World Health Organization; 2019.
14. Agarwal S, Perry HB, Long LA, Labrique AB. Evidence on feasibility and effective use of mHealth strategies by frontline health workers in developing countries. Trop Med Int Health. 2016;20(8):1003-1014.
15. Althabe F, Therrien MNS, Pingray V, et al. Postpartum hemorrhage care bundles to improve adherence to guidelines: a WHO technical consultation. Int J Gynaecol Obstet. 2020;148:290-299. doi:10.1002/ijgo.13028.
16. Osei E, Mashamba-Thompson TP. Mobile health applications for disease screening and treatment support in low- and middle-income countries: a narrative review. Heliyon. 2021;7(3):e06639. doi:10.1016/j.heliyon.2021.e06639.
17. Labrique AB, et al. Best practices in scaling digital health in low- and middle-income countries. Glob Health Sci Pract. 2018;6(2):215-228.
18. World Health Organization. Trends in maternal mortality. Geneva: World Health Organization; 2023.

Figures

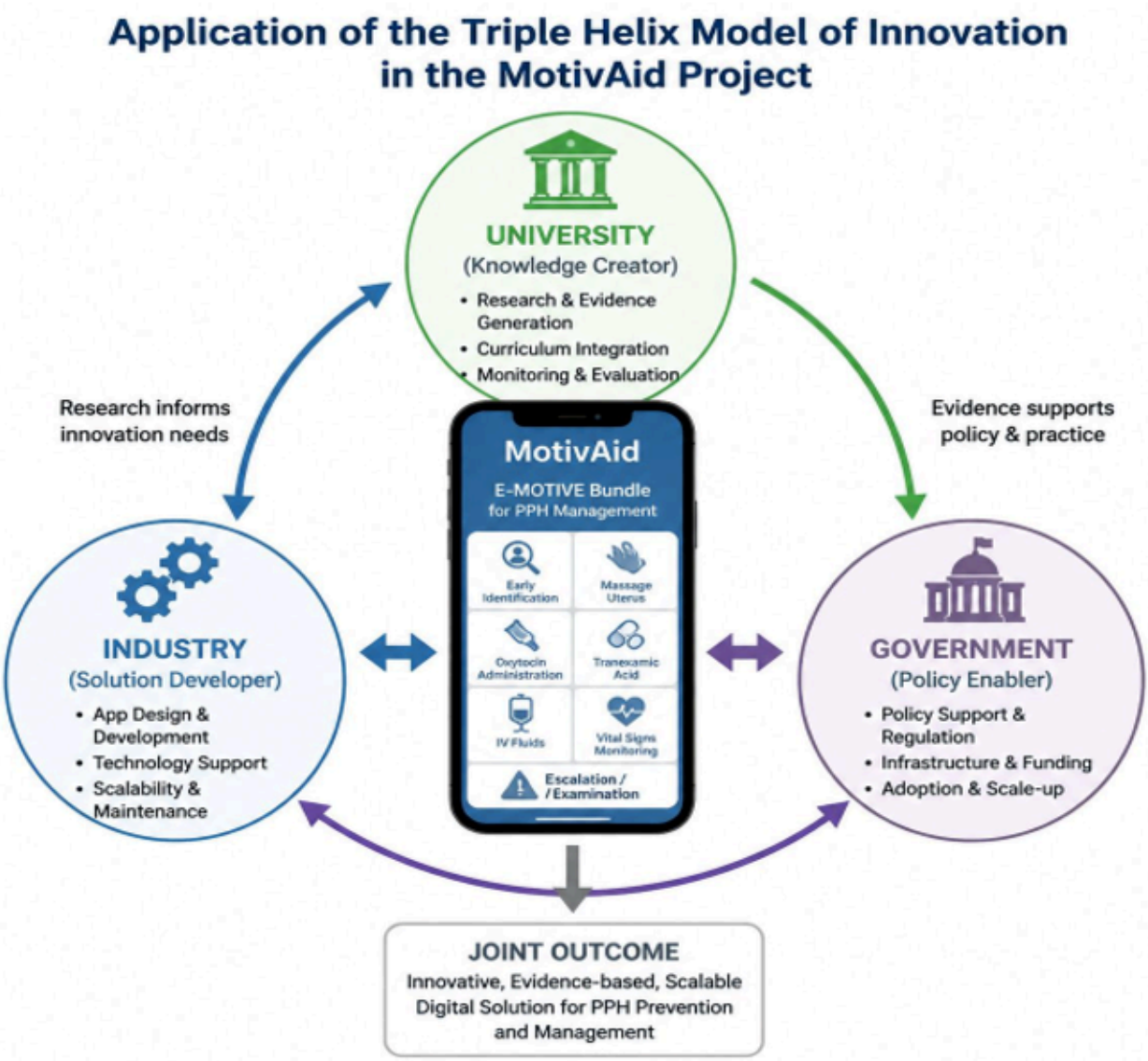


Figure 1

Application of triple helix model of innovation in MotivAid

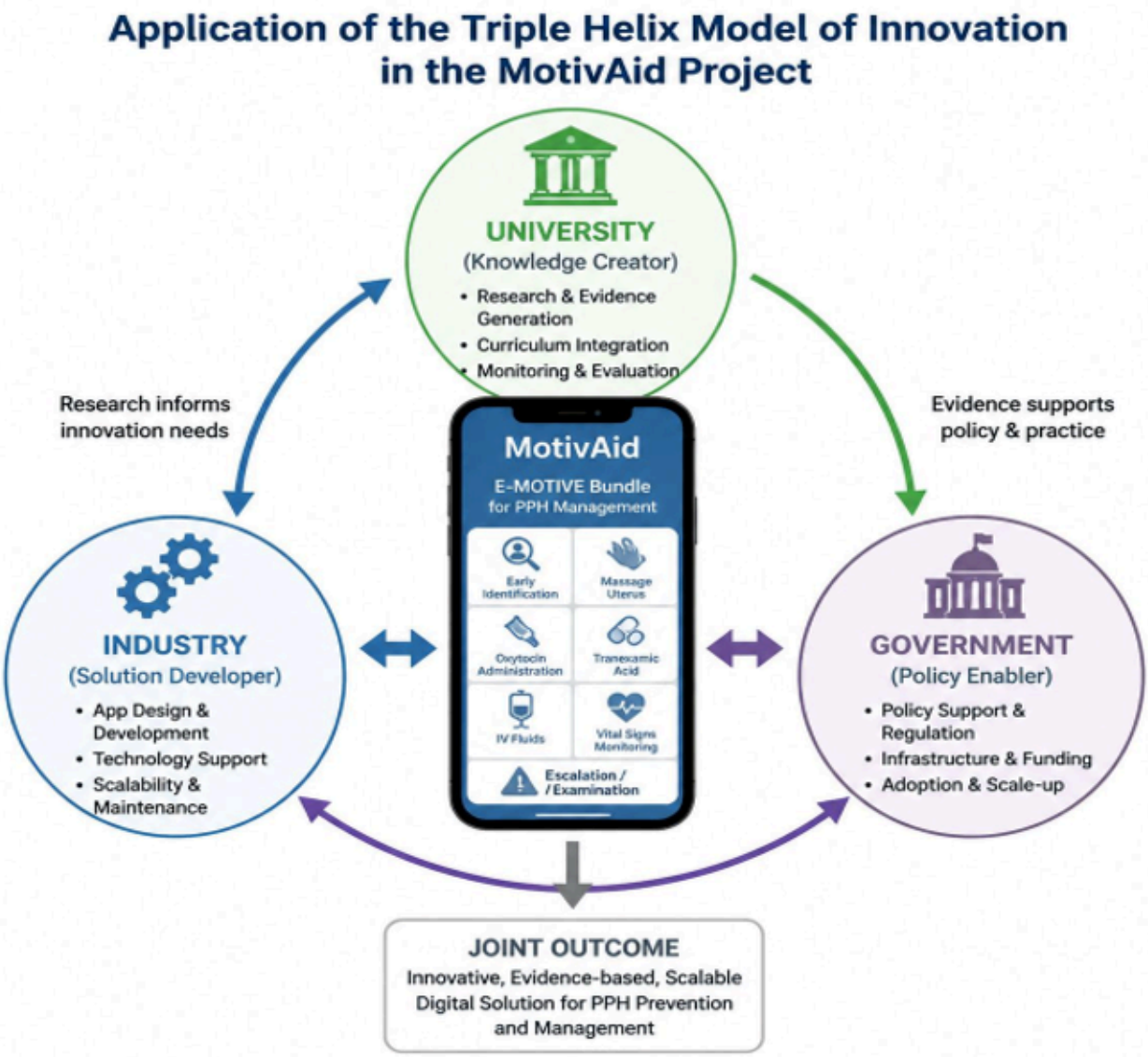


Figure 1

Application of triple helix model of innovation in MotivAid

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryFile083144.docx
- SupplementaryFile083144.docx