

## Appendix S1 – Reflexivity Statement

### 1. How does this study address local research and policy priorities?

This research is directly supporting the National Immunization Program in Pakistan. Routine Immunization coverage in Pakistan continues to lag national and international goals; the percentage of children who are fully vaccinated is as high as ~90% in Punjab province but <40% in the province of Balochistan. This study provides insight into the allocative and technical efficiencies which could be achieved with the existing resources, or more resources, and links to operational recommendations. We have communicated with the Research and Decision Support (RADS) Team at the National Emergency Operations Centre (NEOC), in consultation with the Innovations and Operational Research (IOR) Task Team, which is composed of members from all partner organizations, as well as their nominated provincial research officers. We are planning follow-up engagement and dissemination activities around the research findings and implications.

### 2. How were local researchers involved in study design?

The study was instigated through dialogue among international partners which included their local representatives in Pakistan (particularly AK). The unit cost estimation sub-study was fully designed and conducted by local researchers HY and AN. The optimization analysis was designed by high-income country researchers with subject experience but in collaboration and consultation with the local researchers.

### 3. How has funding been used to support the local research team?

The World Bank funded PFM Solution to conduct the costing sub-study. The World Bank also funded the Burnet Institute to conduct optimization analyses.

### 4. How are research staff who conducted data collection acknowledged?

All staff who conducted data collection were included as authors.

### 5. Do all members of the research partnership have access to study data?

All members of the partnership have access to the study data.

### 6. How was data used to develop analytical skills within the partnership?

Costing data were used by the analytical experts to further develop trade-off assessment skills between objectives. The approach and technical details were also discussed at length with the Funder and with the local costing team to build their knowledge of the analytical skills.

### 7. How have research partners collaborated in interpreting study data?

A core group consisting of the costing team (HY), analytical team (DPW, FH) and funder (RO) on a very regular basis reviewed all data and outputs from analyses and their interpretation. Other research partners were consulted regularly on key issues throughout the project. Then, at milestone points in the project and development of the paper, all authors were consulted and collaborated in interpretation, messaging, and editing of the paper.

**8. How were research partners supported to develop writing skills?**

Post-doctoral early career researcher FH led the writing of the manuscript. Local experts were funded to contribute relevant components to the manuscript. Both the senior author and the funder worked with these writers in editing and refining the manuscript. All other authors then also contributed to the collective manuscript.

**9. How will research products be shared to address local needs?**

The World Bank is leading the dissemination of findings with the federal and provincial governments of Pakistan as well programmatic governance entities – e.g. the Research and Decision Support (RADS) Team at the National Emergency Operations Centre (NEOC), in consultation with the Innovations and Operational Research (IOR) Task Team, which is composed of members from all partner organizations, as well as their nominated provincial research officers. The World Bank, in partnership with the Bill & Melinda Gates Foundation, will also facilitate sharing of results with other international partners working to address local needs in Pakistan.

**10. How is the leadership, contribution and ownership of this work by LMIC researchers recognised within the authorship?**

Hammad Yunus, CEO of PFM (Public Financial Management) Solutions in Pakistan, led the costing sub-study as input into the larger study and therefore has second author position. Aliya Kashif MD, MBA, MPH, in Pakistan, is a Senior Health Specialist at the World Bank and the Co-Task Team Lead (Co-TTL) on the National Immunization Support Project (NISP), and Hnin Hnin Pyne in Bangkok, is responsible for advancing the World Bank's engagement in the health sector in Pakistan and elsewhere. Representing the funder of the study, they are co-authors but not lead authors. Amber Naim, director of PFM Solutions, supported the unit cost estimation study and is provided authorship prominence before all funders and academics.

**11. How have early career researchers across the partnership been included within the authorship team?**

Early career researchers (FH, DD, AP, ES) were included within the authorship team. ES estimated the sub-populations at the district-level, and AP and DD developed the data envelopment analysis and allocative efficiency optimization models. FH conducted the modeling and post-processing. We attempted to fairly balance authorship between LMIC and ECR researchers.

**12. How has gender balance been addressed within the authorship?**

Five authors are male (HY, DD, NS, RO, DPW) and six authors female (FH, ES, AP, AN, AK and HHP). The first author is female and the last author is male.

**13. How has the project contributed to training of LMIC researchers?**

This project was not predominantly a capacity building project but a research project to inform programming for improved health outcomes. LMIC researchers were actively involved in leading sub-components and in the design of the study and interpretation of results.

**14. How has the project contributed to improvements in local infrastructure?**

This project has not directly contributed to improvements in local infrastructure.

**15. What safeguarding procedures were used to protect local study participants and researchers?**

The data collected and subsequently used in the study was de-identified / aggregated data and no individual community members provided data for this study.