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Making ICTs work for health: protocol for a mixed-methods study exploring processes for institutionalizing geo-referenced health information systems to strengthen MNCH service planning, referral and oversight in urban Bangladesh

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3 **Title: Making ICTs work for health: protocol for a mixed-methods study exploring**
4 **processes for institutionalizing geo-referenced health information systems to strengthen**
5 **MNCH service planning, referral and oversight in urban Bangladesh**
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26 27 28 *Author Contributions* 29

30 RI & AA conceptualized the study. RI & AA prepared the first draft of the manuscript. SMH,
31
32 RA, DSB and SS revised the manuscript. RI & AA reviewed critically for important intellectual
33
34 content; SS revised the version submitted with inputs from all other co-authors.
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3 *Competing interests*
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19 *Study period*
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26 *Data statement section*
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28 Data will be handled according to the principles of the icddr,b policies and guidelines of the
29 International Development Research Centre, Canada.
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Abbreviations

ADB	Asian Development Bank
CCs	City Corporations
DGHS	Directorate General of Health Services
ERC	Ethical Review Committee
GIS	Geographic Information System
HMIS	Health Management Information System
ICT	Information Communication and Technology
IDI	In-depth Interviews
KII	Key Informant Interviews
LMICs	Low and Middle Income Countries
MNCH	Maternal, newborn and child health
MOHFW	Ministry of Health and Family Welfare
MOLGRDC	Ministry of Local Government, Rural Development and Cooperatives
NGOs	Non-Government Organizations
PHC	Primary Health Care
RRC	Research Review Committee
SDGs	Sustainable Development Goals
UHA	Urban Health Atlas
UHC	Universal Health Coverage
WHO	World Health Organization

Article Summary

Strengths and limitations of this study

- This mixed method implementation research is among the first in Bangladesh to explore processes for institutionalizing geo-referenced health information systems to strengthen MNCH service planning, referral and oversight in urban areas
- The proposed research will generate knowledge to enhance understanding of how geo-referenced health facility information can inform MNCH service planning and decision-making.
- This study is expected to provide valuable guidance beyond Bangladesh's HMIS on how to generate user buy-in, and policy uptake necessary to introduce MNCH-related ICTs in developing country contexts. The result of the study also might guide future intervention to scale up and sustain ICT tool into national HMIS
- This is a mixed-method implementation research applying pre-post design. Since it is not a quasi-experimental or Cluster randomized study, the evidence generated about the effectiveness of the intervention or proving causal relationship is difficult. Besides, the study is designed based on the consideration of local context of two municipalities outside Dhaka and two city corporations within Dhaka. There has been growing literature that the urban spectrum in Bangladesh is diverse in terms of population size, informal economy, public transport, and health outcomes. Therefore the result of this study might not be generalizable for all cities, but it will contribute to understand the urban context of Bangladesh.

- The sites selected for the study implementation is based on the availability of MFL and the UHA. Other cities, not included in the study, may have different experiences than the ones studied.
- Also, countries with different geo-political administration system, such as federal and state level divisions in governance, may face additional barriers in the institutionalization of the health ICTs. Hence the findings may not be widely generalizable. However, the insights generated will be relevant for health ICT implementation and can be built upon with further research both nationally and internationally.

ABSTRACT

Introduction: Disparities in health outcomes and access to maternal neonatal and child health (MNCH) are apparent among urban poor compared to national, rural or urban averages. A fundamental first step in addressing inequities in MNCH services is, knowing what services exist in urban areas, where these are located, who provides them, and who uses them. This study aims to institutionalize the Urban Health Atlas (UHA) - a novel ICT tool - to strengthen health service delivery and oversight and generate critical evidence to inform health policy and planning in urban Bangladesh.

Methods and analysis: This mixed-method implementation research will be conducted in purposively selected two City Corporations and two municipalities. Research activities will include an assessment of information needs and task review analysis of information users, stakeholder mapping, and cost estimation. To document stakeholder perceptions and experiences, Key Informant Interviews (KIIs) and In-depth Interviews (IDIs) will be conducted along with desk reviews to understand MNCH planning and referral decisions. The UHA will be refined to increase responsiveness to user needs and capacities and hands-on trainings will be provided to health managers. Cost estimation will be conducted to assess the financial implications regarding the uptake and scale up of UHA. Systematic documentation of the implementation process will be done. Policy decision-making and ICT health policy process flowcharts will be prepared using desk reviews and qualitative interviews. Thematic analysis using codes guided by WHO PATH toolkit and Policy Engagement Framework will be conducted for qualitative data. Stakeholder analysis will apply standard techniques and measurement scales. Descriptive analysis of quantitative data and cost estimation analysis will also be performed.

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3 **Ethics and dissemination:** The study has been approved by the Institutional Review Board of
4 icddr,b (# PR-16057). Study findings will be disseminated through national and international
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6 workshops, conferences, policy briefs and peer-reviewed publications.
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11 **Keywords**

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14 Urban health, maternal, neonatal and child health, information communication and technology,
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16 geographic information systems, health management information systems, Bangladesh.
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INTRODUCTION

Bangladesh has embraced the Sustainable Development Goal-3 (SDGs) of achieving universal health coverage by 2030[1], however, there remain several challenges such as burgeoning population at all ages, pluralistic health systems, lack of governance and many more[2]. Despite the substantial progress Bangladesh has made in reducing maternal and child mortality[3], there are significant disparities in health-related outcomes and access to maternal neonatal and child health (MNCH) services along with socioeconomic and geographic dimensions. Health indicators are far worse in urban slums than the non-slum urban and the national average[4]. Nationally, mortality rate for children under five years of age is 65 per 1,000 live births while the rate is 81 per 1000 live births among urban slum residents in Bangladesh[4, 5]. Undergoing a rapid urbanization, Bangladesh projects by 2040 more than half of its citizens will reside in urban areas and almost one-third of them in slums[6]. Persistent inequities in key MNCH indicators in urban areas highlight the need to focus on issues of service coverage, access, quality and timely and appropriate referral as urgent policy priorities.

The Bangladesh urban health system is a smorgasbord of service providers with very little coordination and regulation[7, 8]. Several reasons have been proposed for inefficiencies in the system including poor planning and management capacity, poor coordination among the authorities, lack of clear, separate roles and responsibilities for the various authorities, service coverage gaps, and human resource management issues[9,10]. One consequence of the limited formal system of Primary Care Services in urban areas[11] is the emergence of the private sector in health including the proliferation of informal providers such as pharmacies. Currently, the formal private sector accounts for 80% of over 3500 hospitals in Bangladesh and lack of regulation of this sector has resulted in concerns about quality of care and accessibility,

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3 especially for the urban poor, and presents challenges to moving towards universal health
4 coverage[10].
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7 A fundamental first step in addressing all these challenges in MNCH services in urban
8 Bangladesh is an in-depth understanding of what services exist, their location, who provides
9 them, and who utilizes them. A strong health management information system (HMIS), an
10 essential component of sound programme development and implementation, can leverage such
11 particulars as a requirement for strategic decision-making, better governance, and the basis upon
12 which improved health outcomes depend[12, 13]. A Master Facility List (MFL) is a crucial
13 constituent of HIS and permit the linkage of sub-systems in a national HIS architecture[14, 15].
14 Such MFL creation is being advocated by The World Health Organization (WHO) for ensuring
15 better governance including systematic reporting and monitoring supervision[16,17].
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18 Realizing the critical role that health information systems play in health management and
19 building on political commitment towards “Digital Bangladesh”, the Bangladesh Directorate
20 General of Health Services (DGHS), Ministry of Health and Family Welfare (MOHFW) is
21 implementing the district health information software-2 (dhis2) with support from development
22 partners. While the system has been rolled out nationally, information is largely confined to
23 public health facilities in the country. With the exception of large public hospitals, and a handful
24 of NGOs, data are currently unavailable for urban facilities in the system.
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27 Addressing this gap, icddr,b has created geo-referenced health facility databases for several major
28 cities across Bangladesh. This dataset highlighted areas of service duplication and gaps in
29 provision of MNCH services in poor urban settlements[18], enabled through the development of
30 an Information Communication and Technology (ICT) tool called *Urban Health Atlas*
31 (UHA)[19]. The UHA displays health facility data visually and permits their manipulation for
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3 better planning and referral for urban health. One of the strengths of this dataset is inclusion of
4 private sector in healthcare, from pharmacies to hospitals. The promise of UHA has intrigued
5 multiple stakeholder groups, ranging from the Directorate General of Health Services (DGHS),
6 local government, non-government organizations (NGOs), implementers and development
7 partners. In the context of significant investments in urban health systems strengthening that are
8 in pipeline, and absence of urban data in the national Management Information System (MIS),
9 UHA is perceived timely and appropriate to be used and scaled up for guiding urban health
10 planning process through institutionalizing such geo-referenced health facility information
11 system. However, due to complexity of these kind of data, they risk being underutilized for
12 health policy and planning unless specific efforts are attempted for making them more accessible
13 to non-technical, policy and other local level stakeholders[20]. The purpose of this study,
14 therefore, is to pilot the UHA for use in MNCH service delivery planning and referral, and by
15 generating evidence on its utility, inform and strengthen advocacy for and action around its
16 institutionalization into the government system with a view that the study fills an important
17 information gap.

38 39 40 **Study Aims**

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42 Three specific aims are identified for this study in order to institutionalize the UHA for MNCH
43 service delivery, planning, and referral into the government system:

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47 1. To document stakeholder perceptions and experiences in adopting a tool that enables use
48 of health facility information for strategic planning, day-to-day decision-making, control
49 and oversight, and improved administrative efficiency of urban MNCH services.
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3. To identify policy and programmatic entry points that will facilitate broader use of geo-referenced health facility information and its regular update.
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8. To estimate costs associated with bringing geo-referenced facility listing into the government system
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METHODS

Study design and participants

The proposed implementation research employs a mixed method research approach to understand the processes by which an ICT tool that enables the visualization of health facility information, can contribute towards improving MNCH services for the urban poor. It will assess the uptake of UHA by the MNCH planners and position of the stakeholders and decision makers over a 3-year period from 2016-2019.

Theoretical frameworks

Two frameworks have been used to inform and guide this study: (i) WHO PATH toolkit[17]; and (ii) policy engagement framework[20]. The introduction of a new ICT tool is commonly accompanied by challenges that must be overcome. Before scaling up, it is important to conduct rigorous product planning and feasibility testing, and to identify and engage key stakeholders. In this regard, a toolkit has been published by WHO and PATH to guide the introduction and implementation of information and communications technology (ICT) in health information systems[17]. Drawing on this, three main phases of an ICT project is identified: pilot, scale, and sustain. In the pilot phase, the phase addressed in this study, a solution (UHA) is developed based on program needs and priorities, and tested on a small-scale to measure outcomes,

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3 impacts, and costs, and identify potential improvements. Several other factors influence the
4 introduction of the HMIS in developing countries including planning, stakeholders roles and
5 responsibilities, cultural aspects, human capacity, financial aspects sustainability etc.[21],
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7 informed the first conceptual framework (figure 1).
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12 In order to explore user perceptions, and policy and programmatic entry points, the policy
13 engagement framework[20] will be employed to prospectively analyze policy that incorporates
14 strategies for change. This framework will confer a systematic approach to the ongoing
15 collection, analysis and use of political information (e.g. concerning actors, their interests,
16 institutions, ideas, and policy processes and context) that can alter the balance of power between
17 those in support of and those resisting change by enabling pro-reformers to intervene more
18 effectively in the policy process[20].
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30 31 **Study sites**

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33 Two city corporations (CCs) – namely Dhaka North City Corporation (DNCC) and Dhaka South
34 City Corporation (DSCC) and two municipalities Jessore and Dinajpur which have geo-
35 referenced health facility data available from previous mapping exercise of icddr,b,[19] will be
36 purposively selected. Jessore and Dinajpur municipalities will also be selected as they present
37 marked differences from CCs in terms of size, structure, capacity and challenges posed.
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47 **Sample size**

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49 Through the stakeholder mapping, key urban MNCH decision-making actors at both national and
50 local levels will be identified which will help identify potential users for UHA. They will be our
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study respondents and training participants. The sampling strategy, type and number of respondents for each study activity are provided in table 1.

Table 1 Sampling strategy and sample type for each activity of the study

Activity and focus	Data collection methods	Sampling strategy	Respondent group	Sample size*
Task Review (document how MNCH planning and referral decisions are currently made)	KIIIs	Opportunistic/emergent sampling; Snowball sampling	–Urban health systems actors –National and local government officials –NGO programme managers	16
	Desk review	N/A	N/A	N/A
User Need and User Experience (explore user preferences, task needs and	IDIs (on user needs)	Opportunistic/emergent sampling; Snowball sampling	–Policy makers within the MOHFW –Members of the Urban Health	16

<p>experiences)</p>			<p>Cell of MOLGRDC –Managers at City Corporations –NGO programme managers</p>	
	<p>IDIs (on user experience)</p>	<p>Opportunistic/ emergent sampling; Snowball sampling</p>	<p>–Policy makers within the MOHFW –Members of the Urban Health Cell of MOLGRDC –Managers at City Corporations –NGO programme managers</p>	<p>16</p>
<p>Policy Engagement (understand</p>	<p>KIIs</p>	<p>Opportunistic/ emergent</p>	<p>–Urban health systems actors</p>	<p>15</p>

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interactions between content, context, actors and processes of policy advocacy and entry points for sustainable incorporation of ICT into health systems)		sampling; Snowball sampling	–National and local government officials –NGO programme managers	
	Desk review (urban health and ICT related policies)	N/A	N/A	N/A

ICT, Information Communication and Technology; IDI, In-depth Interviews; KII, Key Informant Interviews; MNCH, Maternal, newborn and child health; MOHFW, Ministry of Health and Family Welfare; MOLGRDC, Ministry of Local Government, Rural Development and Cooperatives.

Implementation procedure of the pilot

The study implementation is envisaged with stakeholder sensitization and developing partnership with government. This is critical because the research will closely work with government health system in urban areas, so for its successful implementation. In addition to this, there will be intervention to conduct capacity building sessions for the government managers and actors of urban health around the use of the UHA. The details of these activities are provided below.

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6 *Stakeholder consultation and engagement:* Two stakeholder consultation workshops will be
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8 carried out to identify and engage key stakeholders for advocacy to avoid failure and resource
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10 wastage. Detail information on identification and mapping of stakeholders has been described in
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12 the data collection section. Ideas will be generated for uptake, regular use, and update of UHA.
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17 *Partnership development with Government:* For implementation partnership with Management
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19 Information System (MIS), DGHS, MOHFW will be developed and a Memorandum of
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21 Understanding will be signed between icddr,b and DGHS. Permission letters will also be
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23 obtained from mayors of CCs and municipalities.
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28 *Capacity building on UHA:* Hands-on UHA training workshops will be organized for
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30 stakeholders involved in urban MNCH services planning and implementation. During and
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32 following these workshops, participants will conduct several applied exercises to further
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34 consolidate skills and comfort in using UHA. A total of 6 trainings will be conducted in three
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36 field sites and for each training session 20-22 participants will be invited. The participants will
37
38 be from policy makers within the Ministry of Health and Family Welfare (MOHFW), members
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40 of the Urban Health Cell of Ministry of Local Government, Rural Development and
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42 Cooperatives (MOLGRD&C), Chief Health Officers at City Corporations, NGO programme
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44 managers.
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3 *Modification ICT tool:* Based on the feedback received from stakeholders as well as the study
4 participants the UHA will be modified throughout the study. A prototype of a mobile application
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6 will be developed and feasibility of this application will be explored.
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10 11 12 **Data collection**

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14 Interviews will be conducted by an experienced group of researchers trained in qualitative
15 interviewing. The team consists of a mixed method expert, a qualitative & ethnography expert
16 and two software programmers, one GIS expert and an economist. The team will begin data
17 collection in Dhaka (both city corporations), then move to the municipalities to ensure the
18 convenience in terms of time and travelling. A period of rapport building with key stakeholders
19 in each study site will be critical to the success of this research given known difficulties in
20 accessing the Government sector with their workload. Networks and negotiation will be
21 important in opening doors and initiating discussion. The UHA tool will be assessed for impact
22 on MNCH decision-making and outcomes. It is unlikely, however, that these effects would be
23 apparent within three years of implementation. Thus, success of the tool will be determined
24 based on user experiences as specified by WHO PATH Toolkit i.e. better indicators for strategic
25 planning, day-to-day decision-making, control and oversight, and reduced administrative burden.
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44 *Data collection methods for objective 1*

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46 To address objective 1, assessment of information needs and task review analysis will be done by
47 desk review, in-depth interviews and click streams. Guidelines for **qualitative interviews** will be
48 developed based on the WHO PATH toolkit's questions to measure success. Three qualitative
49 research activities are envisaged to address this objective:
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1. Key informant interviews (KIIs) with urban health system actors along with desk reviews to understand and document how MNCH planning and referral decisions are currently made.
2. In-depth interviews (IDIs) with potential UHA users to explore user preferences and task needs to refine the tool in advance of training.
3. IDIs with UHA users to understand their experiences and to document challenges and successes of using UHA for MNCH service decision-making during training and one- & three-months post-training.

In addition to qualitative assessments of user experiences, how different stakeholders are using data remotely through quantitative assessments of (i) User's click streams; (ii) Task time devoted to different applications will be monitored. Written feedback through online tools (i.e. Google Analytics) that facilitate remote testing will also be collected and further used to generate more user-friendly functions that meet user needs.

Data collection methods for objective 2

To identify entry points that will facilitate broader use of geo-referenced facility information and its regular update, stakeholder mapping, policy mapping using desk review, KIIs, and stakeholder consultation workshop will be conducted. Guidelines for qualitative interviews will be developed using the policy engagement framework as a guide. Policy and programmatic entry points for the broader use and update of facility information, stakeholder analysis will be undertaken using Policy Engagement Framework as a guide. Stakeholders are identified as persons, groups, organization members or systems that affect or can be affected by a

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3 project/program/activity. Accordingly, stakeholder analysis is an approach for generating
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5 knowledge about roles, behavior, inter-relation and intention of associated actors and their
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7 influence in implementation processes of a program or policy[22]. Given the importance of
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9 stakeholder satisfaction and support for the success of any program,[23,24] incorporating
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11 stakeholders' perspectives and needs is a critical step in gaining ownership around an ICT
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13 innovation like UHA and its incorporation into routine information systems, and use for
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15 decision-making. Following qualitative methods will be used to fulfil objective 2:
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19 - Stakeholder mapping including the identification and listing of stakeholder groups
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21 involved in urban health based on available literature and expert opinion.
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- 24 - A semi-structured guideline will be used to collect information during stakeholder
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26 consultation workshops to explore their respective interests, roles and responsibilities
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28 in urban health, their information needs, and perceptions of how they can contribute
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30 to institutionalizing UHA.
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- 33 - KIIs along with desk reviews to understand the processes of current health policy-
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35 making mechanisms and what other policies affect the integration of ICT in health.
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40 *Data collection methods for objective 3*

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42 To estimate cost of bringing facility listing into the government information system total cost of
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44 ownership for UHA development and implementation will be estimated using ingredient
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46 approach. Data will be collected through structured questionnaire, document review and KII.
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48 Cost will be estimated only supply side aspects. The budget matrix will be developed with cost
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50 drivers proposed in the WHO PATH toolkit.
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The cost for development and implementation of Urban Health Atlas (UHA) tools, coordination, and engagement of city corporations and DGHS will be estimated. Both financial costs and economic costs of the program shall be estimated. Financial costs represent the actual expenditures on goods and services purchased. Economic costs include the estimated value of goods or services for which either there are no financial transactions or the price of a specific good did not reflect the cost of using it productively elsewhere[25]. The cost will be separated for start-up cost and implementation cost. The implementation cost comprise the costs required to run and for regular maintenance of the ICT tools while executing intervention[26].

All supply-side inputs will be identified, quantified and valued through facility-level inventory, record review and key informant interview. Fixed cost and variable cost will be captured. Shared cost items, including salary, buildings, furniture, supervision, transportation, and vehicles, will be identified through observation and interviews of relevant personnel. The shared costs will be apportioned by proportion of the time-involvement of the relevant items (like, office rent, common vehicle) to different activities. The time of the volunteers will be transformed into costs by using the minimum wage level of manual workers in Bangladesh. There are some examples of components included in ingredient approaches (table 2)[26, 27]:

Table 2 Components included in ingredient approaches for cost

Method Name	Methodology	Inputs	Activities
Ingredients approach	Quantities x price, personnel, percentage use	personnel, ICT tools, vehicles,	Personnel , ICT tools, vehicles

ICT, Information Communication and Technology.

To identify activities of the UHA tool implementation and their related inputs, a review of program documents and interviews with relevant personnel will be conducted. The unit price/salary information will be collected from responsible program management. In case of missing unit price of any items, the market price of those items will be collected. Semi-structured checklists for cost data collection will be developed considering the program context and using WHO PATH toolkit as a guiding framework. The budget matrix will be completed with help from key personnel associated with costing and budgeting identified during the stakeholder mapping and research team's own estimates.

Data analysis

A process flowchart for current decision-making practices will be prepared using the KII and Organizational process reviews. A list of user needs will be made and shared at a stakeholder consultation meeting to identify the most important and feasible functions to be added to UHA.

For *qualitative data*, an outline plan for data analysis will be prepared in advance of research along with a priori codes. These codes, mostly focusing on user experience, will be derived from the WHO PATH toolkit[17]. The analysis will be open to emerging themes as well. All interviews will be recorded provided consent has been obtained, but with simultaneous note taking in case of equipment failure. Data transcription will occur immediately following each interview, followed by translation. Data familiarization will involve reading transcripts repeatedly to surface emerging themes and identify any missed opportunities for further

exploration. Transcripts will be coded using Atlas-ti (version-7.5.7). A team approach to analysis will be employed to minimize individual biases. Inter-coder reliability will be checked. Group discussions of emerging themes and patterns in the data will be tested using data displays that allow more systematic pattern-testing across respondents.

For *stakeholder analysis*, stakeholders' influence, importance and agreement will be explored applying standard techniques and measurement scales mentioned in table 3. A position diagram with level of agreement and level of influence will also be plotted to identify stakeholders who are already convinced to work and help institutionalize UHA and who need to be brought into agreement.

Table 3 Operational definitions for stakeholder analysis for policy engagement

Theme	Terms used	Operational definition
Influence, importance and agreement analysis of stakeholders	Level of influence	Stakeholders' influence will be determined according to each stakeholder group's perception and views on who is important in terms of urban health care delivery.
	Level of agreement	Stakeholders' agreement will be determined according to how much each stakeholder agreed.
	Level of importance	The stakeholders' importance will be determined according to how important each stakeholder group is to the other groups.
Power and	Overall power	Power of a stakeholder-group will be assessed as

leadership

compared to all other groups in Bangladeshi urban healthcare delivery system. Power of stakeholders will be measured as the product of multiplication of influence and importance.

Relative position

Relative position of each stakeholder group will be assessed by comparing one group's position to other groups in broader scenario.

Relative positions of stakeholders

Drivers

Stakeholders who have high level of importance as well as high level of influence on public sector health care delivery system

Supporters

Stakeholders who have high level of importance but low level of influence on urban healthcare delivery system

Bystanders

Stakeholders who have low level of importance and low level of influence on urban healthcare delivery system

Abstainers

Stakeholders who have no influence and no importance on urban healthcare delivery system

Blockers

Stakeholders who have low level of importance but high level of influence on urban healthcare care delivery system.

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3 For *policy engagement analysis*, results from stakeholder analysis will be used to identify links
4 between actors in the process of implementation and uptake. KIIs conducted will contribute
5 towards a comprehensive understanding of interactions between content, context, actors and
6 processes of policy advocacy and entry points crucial for sustainable incorporation of ICT in
7 health systems. Interviews will be analyzed using a priori codes drawn from the Policy
8 Engagement Framework. Emphasis will be given on the processes of current health policy
9 development mechanisms and effect of other policies for integration of ICT in health. A Health
10 Policy for ICT process flowchart will be prepared. Information on how context is considered and
11 dealt with when policies are formed and what processes need to be changed to integrate UHA
12 into the system according to policy engagement framework[20].
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28 For *quantitative data*, simple descriptive analysis will be performed to show user rates by
29 different stakeholders. A set of parameters to be analyzed are: number of users who accessed
30 UHA, type of users, scope of UHA use, and types of problems faced. For data analysis, software
31 like MS Excel and STATA will be used as appropriate.
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40 *Cost* of implementing UHA will be estimated using a direct approach. Average cost for each
41 activity will be calculated. All supply-side inputs will be identified, quantified and valued
42 through record review and KIIs. Shared cost items, including salary, buildings, furniture,
43 supervision, transportation, and vehicles will be identified through observation and interviews of
44 relevant personnel. By considering the nature of inputs, these will be categorized into capital,
45 recurrent as well as fixed and variable cost items. Shared costs will be apportioned by
46 proportion of the time-involvement of the relevant items (office rent, common vehicle) to
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3 different activities. The inputs will be identified using discussion with relevant personnel,
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5 observation and record review. If unavailable, market prices will be applied to estimate costs.
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7 The capital items will be annualized, and common costs will be apportioned as per requirement.
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9 Annual values of capital items will be estimated from their expected useful life years and
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11 annuitization will be done using 3% discounting rate whenever applicable[28]. The study will
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13 allocate the cost for shared items (e.g. office space, appliances) by using actual utilization of
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15 items for this activity. Utilization information of the shared items will be collected from
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17 responsible project staff.
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24 Finally, the cost for shared items will be estimated by multiplying percentage-use information
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26 with the total cost of the items. Total cost will be calculated by summing up the start-up and
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28 implementation costs. Relative contribution of start-up and implementation cost will be
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30 calculated. The cost-drivers in each activity will be identified considering the larger share of total
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32 cost.
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38 **Process documentation**

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40 In addition to all these activities, the study investigators will systematically document the
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42 implementation process for policy uptake and institutionalization of UHA, focusing particularly
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44 on the contextual factors and their influence on implementation process using a process
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46 documentation template. It will be a continuous information gathering process during the project
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48 period. Information will be gathered on different approaches including – field-level activities,
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50 meetings, negotiations, decision-taken, planning, implementation of decisions, resolution of
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52 differences etc.
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6 Among various methods for process documentation, this study will employ three:

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8 - Documents such as meeting notes, list of Technical Advisory Group (TAG) members,
9 TAG lists, Terms of References (ToR) for TAG, field-diaries of project staff outlining
10 their observations
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12 - Images of stakeholder consolation workshop, training and other project activities.
13
14 - Recordings of interviews, trainings, meetings, workshops etc.
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21 This process documentation of the pilot phase for UHA institutionalization will generate
22 supporting knowledge to be applied for the next two phases identified by the WHO/PATH
23 toolkit – scale up and sustain.
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30 31 **Patient and public involvement**

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33 There will be no direct patient or public involvement in this implementation research. However,
34 a Technical Advisory Group (TAG) will be formulated for project governance, which will
35 consist of representatives from Government, development partners, NGOs, academicians and
36 senior researchers and urban health actors. Regular meetings will be held with partners and staff
37 for problem solving. At the end of the study, the TAG will comment on the study findings and
38 contribute to the dissemination plan.
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49 **Ethics**

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51 This study has received ethical approval from the Research Review Committee (RRC) and the
52 Ethical Review Committee (ERC) of icddr,b for critical review of technical competencies in-
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3 depth examination of ethical issues related to local context respectively. As the study involves
4
5 key stakeholders within urban health systems, poses no more than minimal risk to subjects.
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7 Participants will be asked for written consent prior interviewing and will remain anonymous and
8
9 unidentifiable. Tape recorders will be used for recording the discussions in order to collect full
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11 and intact thoughts after obtaining consent. All other form of data will be kept in locked storage,
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13 or controlled access folders, allowing only investigators of the study and members of the ERC of
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15 icddr,b to access information, if needed.
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21 **Dissemination**

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23 Findings from this research will be disseminated at various levels to develop interest and support
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25 from a wide variety of audiences i.e. public, private, NGO, civil society and donors. In doing so,
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27 we hope to build a diverse constituency of individuals and organizations willing and able to
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29 translate evidence yielded by the study, into policy action.
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35 *Local dissemination:* Findings will be presented to relevant local administrators, development
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37 partners and NGOs and other relevant parties (local health practitioners), researchers.
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42 *National dissemination:* A series of interactive workshops and briefing sessions with various
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44 stakeholders will be arranged to create linkage with national fora. The main aim will be to
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46 translate findings in a more visual and engaging format; i.e. research briefs and interactive
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48 project brochures, to reach a range of stakeholders.
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3 *International dissemination:* This will include publishing findings in peer-reviewed journals and
4 presenting in scientific forums, conferences and symposiums and linking with international
5 learning platforms. The main objective is contributing to the global knowledge pool.
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11 **CONCLUSIONS**

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14 The proposed study seeks to understand the utility and processes by which the visualization of
15 geo-referenced health facility information can contribute towards improving MNCH services in
16 terms of strategy development, decision-making and oversight, with a special focus on the urban
17 poor, and how best to approach the existing system for its institutionalization. The results from
18 this study will inform efforts to scale up the generation and application of facility listing data in
19 urban areas nationwide. Beyond Bangladesh, this study is also expected to provide valuable
20 guidance on how to generate user buy-in, and policy uptake necessary to introduce, scale-up, and
21 sustain MNCH-related ICTs in similar LMICs.
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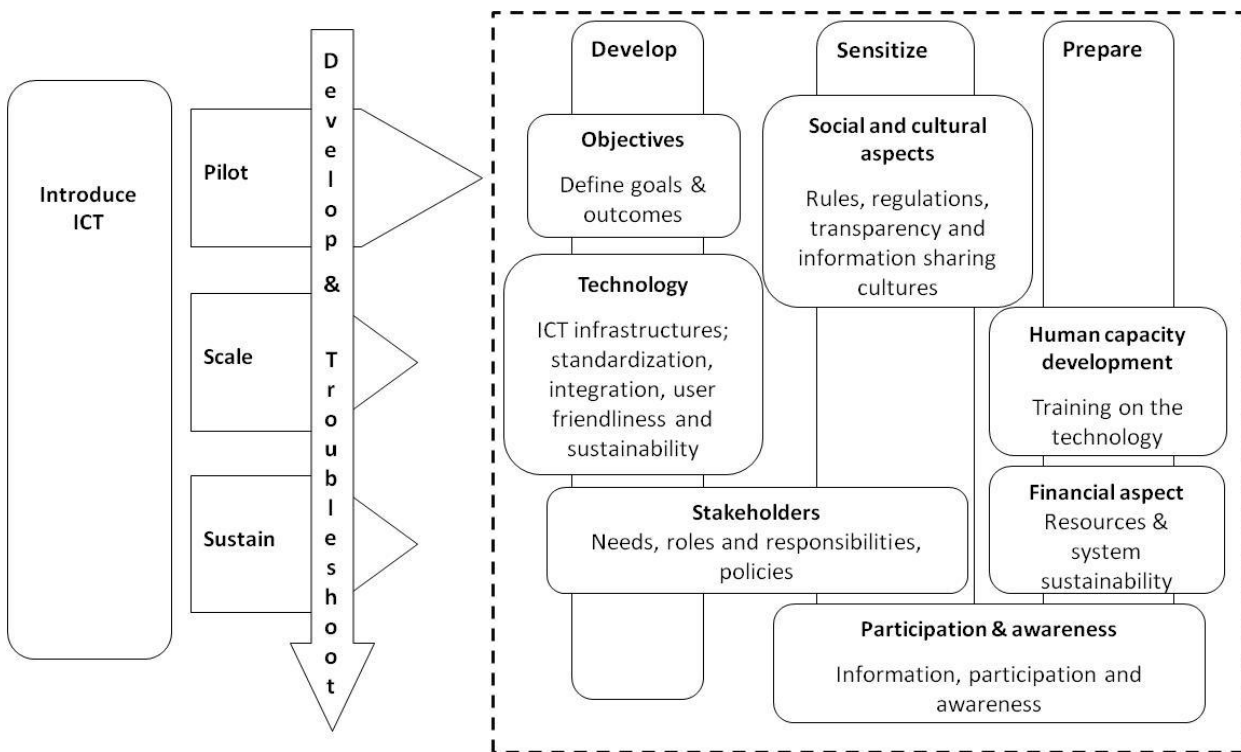


Figure 1. Modified Conceptual framework for Information Communication and Technology (ICT) implementation in developing countries

BMJ Open

Making Information and Communications Technologies (ICTs) work for health: protocol for a mixed-methods study exploring processes for institutionalizing geo-referenced health information systems to strengthen Maternal Neonatal and Child Health (MNCH) service planning, referral and oversight in urban Bangladesh

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Keywords:	Urban health, maternal, neonatal and child health, information communication and technology, geographic information systems, health management information systems, Bangladesh

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Title: Making Information and Communications Technologies (ICTs) work for health: protocol for a mixed-methods study exploring processes for institutionalizing geo-referenced health information systems to strengthen Maternal Neonatal and Child Health (MNCH) service planning, referral and oversight in urban Bangladesh

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30 *Author Contributions*

31
32 RI & AA conceptualized the study. RI & AA prepared the first draft of the manuscript. SMH,
33
34 RA, DSB and SS revised the manuscript. RI & AA reviewed critically for important intellectual
35
36 content; SS revised the version submitted with inputs from all other co-authors.
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3 *Competing interests*
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5 The authors declare no competing interests.
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19 *Study period*
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26 *Data statement section*
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28 Data will be handled according to the principles of the icddr,b policies and guidelines of the
29 International Development Research Centre, Canada.
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Abbreviations

ADB	Asian Development Bank
CCs	City Corporations
DGHS	Directorate General of Health Services
ERC	Ethical Review Committee
GIS	Geographic Information System
HMIS	Health Management Information System
ICT	Information Communication and Technology
IDI	In-depth Interviews
KII	Key Informant Interviews
LMICs	Low and Middle Income Countries
MNCH	Maternal, newborn and child health
MOHFW	Ministry of Health and Family Welfare
MOLGRDC	Ministry of Local Government, Rural Development and Cooperatives
NGOs	Non-Government Organizations
PHC	Primary Health Care
RRC	Research Review Committee
SDGs	Sustainable Development Goals
UHA	Urban Health Atlas
UHC	Universal Health Coverage
WHO	World Health Organization

ABSTRACT

Introduction: Disparities in health outcomes and access to maternal neonatal and child health (MNCH) are apparent among urban poor compared to national, rural or urban averages. A fundamental first step in addressing inequities in MNCH services is, knowing what services exist in urban areas, where these are located, who provides them, and who uses them. This study aims to institutionalize the Urban Health Atlas (UHA) - a novel ICT tool - to strengthen health service delivery and oversight and generate critical evidence to inform health policy and planning in urban Bangladesh.

Methods and analysis: This mixed-method implementation research will be conducted in four purposively selected urban sites representing larger and smaller cities. Research activities will include an assessment of information needs and task review analysis of information users, stakeholder mapping, and cost estimation. To document stakeholder perceptions and experiences, Key Informant Interviews (KIIs) and In-depth Interviews (IDIs) will be conducted along with desk reviews to understand MNCH planning and referral decisions. The UHA will be refined to increase responsiveness to user needs and capacities, and hands-on training will be provided to health managers. Cost estimation will be conducted to assess the financial implications of UHA uptake and scale-up. Systematic documentation of the implementation process will be undertaken. Policy decision-making and ICT health policy process flowcharts will be prepared using desk reviews and qualitative interviews. Thematic analysis of qualitative data will involve both emergent and a priori coding guided by WHO PATH toolkit and Policy Engagement Framework. Stakeholder analysis will apply standard techniques and measurement scales. Descriptive analysis of quantitative data and cost estimation analysis will also be performed.

Ethics and dissemination: The study has been approved by the Institutional Review Board of icddr,b (# PR-16057). Study findings will be disseminated through national and international workshops, conferences, policy briefs and peer-reviewed publications.

Keywords

Urban health, maternal, neonatal and child health, information communication and technology, geographic information systems, health management information systems, Bangladesh.

Article Summary

Strengths and limitations of this study

- This mixed method implementation research is among the first in Bangladesh to explore processes for institutionalizing geo-referenced health information systems to strengthen MNCH service planning, referral and oversight in urban areas
- The proposed research will generate knowledge to enhance understanding of how geo-referenced health facility information can inform MNCH service planning and decision making.
- This study is expected to provide valuable guidance beyond Bangladesh's HMIS on how to generate user buy-in, and policy uptake necessary to introduce MNCH-related ICTs in developing country contexts.
- The impact of this information system tool on health outcomes cannot be established through this study.

INTRODUCTION

Bangladesh has embraced the Sustainable Development Goal-3 (SDGs) of achieving universal health coverage by 2030,[1] however, challenges related to rapid population growth, pluralistic health systems, and lack of governance, among others, are substantial.[2] Although Bangladesh has made extraordinary progress in reducing maternal and child mortality,[3] there are significant disparities in health-related outcomes and access to maternal neonatal and child health (MNCH) services stratified along both socioeconomic and geographic dimensions. Health indicators are far worse in urban slums than both non-slum urban areas and the national average.[4] Nationally, the mortality rate for children under five years of age is 65 per 1,000 live births and 49 per 1,000 live births in rural areas while the rate is 81 per 1000 live births among urban slum residents.[4, 5] Undergoing rapid urbanization, the country is projected to become over 50% urban by 2040, with almost one-third of urban residents living in slums.[6] Persistent inequities in key MNCH indicators in urban areas highlight the need to focus on issues of service coverage, access, quality and timely and appropriate referral as urgent policy priorities.

The Bangladesh urban health system is a smorgasbord of service providers characterized by inadequate coordination and regulation, and geographic and socioeconomic inequities in healthcare access.[7, 8] Several reasons have been proposed for inefficiencies in the system including poor planning and management capacity, weak coordination among the authorities, lack of clear, separate roles and responsibilities for the various authorities, service coverage gaps, and human resource management issues.[9, 10] Of particular concern in urban areas is the lack of adequate public primary care infrastructure and services which disproportionately impacts the urban poor, and poses significant challenges to the country's aspirations to meet the goal of Universal Health Coverage by 2030.[11] One consequence of limited formal primary healthcare

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3 services in urban areas[12] is the emergence of the private sector in health including the
4 proliferation of informal providers such as pharmacies on which many of the urban poor rely.
5
6 The formal private sector is equally massive, accounting for 80% of over 3500 hospitals in
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8 Bangladesh, and an even greater percentage in urban areas. Lack of regulation of this sector has
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10 resulted in concerns about quality of care and financial accessibility, especially for the urban
11
12 poor.[10]
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16 A fundamental first step in addressing inequities in urban healthcare access is an in-depth
17
18 understanding of what services exist, their location, who provides them, and who utilizes them.
19
20 A strong health management information system (HMIS), an essential component of sound
21
22 programme development and implementation. Enabling the use of data for strategic decision-
23
24 making, better governance, institutionalized HMIS systems represent the foundation upon which
25
26 improvements in health outcomes can be monitored and greater accountability ensured.[13, 14]
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30 A Master Facility List (MFL) is a crucial constituent of HIS and permits the linkage of sub-
31
32 systems within national HIS architecture.[15,16] MFL is advocated by The World Health
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34 Organization (WHO) as an effective means of ensuring better governance including systematic
35
36 reporting and monitoring supervision.[17,18] MFLs like UHA are expected to facilitate health
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38 service planning and management through mapping or visualizing the distribution of health
39
40 services and resources. It can also assist health service providers in identifying appropriate
41
42 referral facilities for patients.[19] These functions can help improve equitable service coverage
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44 and reduce delays in receiving appropriate care, which in turn can impact health outcomes such
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46 as maternal and child mortality among the urban poor. A theory of change is provided in
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48 supplemental file 1.
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3 Realizing the critical role that health information systems play in health management and
4 building on political commitment towards “Digital Bangladesh”, the Bangladesh Directorate
5 General of Health Services (DGHS), Ministry of Health and Family Welfare (MOHFW) is
6 implementing the District Health Information Software-2 (DHIS2) with support from
7 development partners. While the system has been rolled out nationally, information is largely
8 confined to public healthcare facilities. In urban areas, with the exception of large public
9 hospitals and a number of NGOs involved in primary care provision, data are particularly sparse,
10 especially for the massive private sector.
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24 **Urban Health Atlas: A novel ICT tool**

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26 Addressing this information gap, icddr,b has created a geo-referenced health facility database for
27 nine major cities and municipalities across Bangladesh. This dataset consists of a census of all
28 healthcare facilities and the services they provide along with their geo locations.[20] To enable
29 the practical application of this dataset, an Information Communication and Technology (ICT)
30 tool called *Urban Health Atlas* (UHA) was developed (<http://urbanhealthatlas.com>).[21] This
31 GIS-based interactive online tool displays health facility data visually and permits their
32 manipulation for better healthcare planning and decision making. Providing detailed information
33 on the location and services available at public and private health facilities, it allows users to
34 examine gaps and duplication in service provision, assess the coverage of emergency services
35 and the availability of doctors in a 24-hour period, calculate the shortest distance to referral
36 facilities from any location, and determine whether a given facility is licensed and registered.
37 This information is particularly useful in helping healthcare planners and policy makers make
38 informed decisions around the distribution and monitoring of healthcare facilities and services,
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3 and health human resources. For the general public, the tool holds promise in locating a desired
4 healthcare service that is closest in distance, and indicating the shortest path to get there.
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7 A key strength of this dataset is its inclusion of private-for-profit healthcare facilities, from
8 pharmacies to hospitals, in addition to public and private not-for-profit healthcare provision. The
9
10 UHA prototype has been demonstrated both nationally and internationally, and generated a great
11 deal of interest and useful feedback. In Bangladesh, its promise has intrigued multiple
12 stakeholder groups, ranging from the Directorate General of Health Services (DGHS)
13 responsible for national healthcare planning, local government officials, private not-for-profit or
14 non-government organizations (NGOs), service providers and development partners. In the
15 context of significant investments in urban health systems strengthening that are in pipeline, and
16 absence of urban data in the country's national health information system (DHIS2), UHA is
17 widely regarded as timely and useful in the context of current urban health planning processes,
18 and many discussions about its formal linkage to and institutionalization within existing health
19 information systems have occurred.
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38 However, due to the complexity of these kind of data, they risk being underutilized for health
39 policy and planning unless specific efforts are attempted to make them more accessible to non-
40 technical, policy and other local level stakeholders.[22] In the context of UHA, these efforts have
41 included making the data available on the DGHS webpage, and organizing dissemination events
42 in city corporations and municipalities. However, beyond anecdotal reports, there is no
43 systematic information on whether the tool is being used by stakeholders, and how it could be
44 improved to better meet their needs. The purpose of this study, therefore, is to pilot and refine the
45 UHA for use in service delivery planning and referral, and by generating evidence on its utility,
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3 inform and strengthen advocacy for and action around its institutionalization into the government
4 system. A focus on MNCH service delivery was chosen to circumscribe the development of
5 training materials, and to clearly delimit the range of stakeholders that should be engaged.
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11 **Study Aims**

12 Three specific aims are identified in seeking to institutionalize the UHA for MNCH service
13 delivery, planning, and referral into the government system:
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- 15 1. To document stakeholder perceptions and experiences in adopting a tool that enables use
16 of health facility information for strategic planning, day-to-day decision-making, control
17 and oversight, and improved administrative efficiency of urban MNCH services.
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- 19 2. To identify policy and programmatic entry points that will facilitate broader use of geo-
20 referenced health facility information and its regular update.
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- 22 3. To estimate costs associated with bringing geo-referenced facility listing into the
23 government system
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35 **METHODS**

36 This Implementation Research (IR) focuses on the factors and processes that influencing uptake,
37 use and scale-up of ICT tools like UHA. The study will explore barriers in usability,
38 understandability, and utility, as well as policy and other requirements needed to support its
39 systematic implementation in the real world setting of healthcare planning, referral and
40 oversight. The primary audiences of this research are managers and decision makers in the urban
41 healthcare sector of Bangladesh.
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53 **Study design and participants**

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3 The proposed implementation research employs a mixed method research approach. Mixed-
4 method research is a widely used approach in IR.[23] We will assess the uptake of UHA by the
5 MNCH-related planners and decision makers over a 3-year period from 2016-2019. The specific
6 IR variables to be assessed are adoption, appropriateness, feasibility, and implementation cost
7 [23]. Many IR frameworks exist, however it is advised to use a framework befitting program
8 parameters [23]. For this reason, we identified a toolkit specific to the development and use of
9 ICT tools and formulated our conceptual framework accordingly. This helped to operationalize
10 the research as an ICT intervention versus a clinical or health service level intervention, while
11 still retaining some of the features of common IR frameworks, including concerns with guided
12 implementation and innovation, sustainability, and stakeholder input.[23]
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17 The WHO PATH toolkit was published by WHO and PATH to guide the introduction and
18 implementation of information and communications technology (ICT) in health information
19 systems.[18] The introduction of a new ICT tool is commonly accompanied by challenges that
20 must be overcome. Before scaling-up, therefore, it is important to conduct rigorous product
21 planning and feasibility testing, and to identify and engage key stakeholders. The toolkit
22 identifies three main phases of an ICT project: pilot, scale, and sustain. In the pilot phase, the
23 phase addressed in this study, a solution (UHA) is developed based on program needs and
24 priorities, and tested on a small-scale to measure outcomes, impacts, and costs, and identify
25 potential improvements. Several other factors influence the introduction of the HMIS in
26 developing countries including planning, stakeholder roles and responsibilities, cultural aspects,
27 human capacity, financial aspects sustainability etc. (see figure 1).[24] The elements of this
28 ICT-informed framework are similar to that of the different phases of the “replicating effective
29 programs framework” used in IR.[25] For instance, stakeholder needs in our framework are
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3 addressed under the identifying implementation barriers step (pre-conditions phase), the
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5 orientation step of the pre-implementation phase is similar to participation and awareness and
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7 financial aspect elements in our framework, and training and technical assistance of the
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9 implementation phases are addressed through the human capacity development component.
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15 In order to explore user perceptions, and policy and programmatic entry points, the policy
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17 engagement framework[22] also will be employed to prospectively analyze policy that
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19 incorporates strategies for change. This framework will confer a systematic approach to the
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21 ongoing collection, analysis and use of political information (e.g. concerning actors, their
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23 interests, institutions, ideas, and policy processes and context) that can alter the balance of power
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25 between those in support of and those resisting change by enabling pro-reformers to intervene
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27 more effectively in the policy process.[22]
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33 **Study sites**

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35 Two city corporations (CCs) – namely Dhaka North City Corporation (DNCC) and Dhaka South
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37 City Corporation (DSCC) – and two municipalities, Jessore and Dinajpur, which have geo-
38
39 referenced health facility data available from previous mapping exercise of icddr,b[21] will be
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41 purposively selected. As smaller cities, Jessore and Dinajpur municipalities present marked
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43 differences from CCs in terms of size, structure, capacity and challenges posed.
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49 **Sample size**

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52 Through the stakeholder mapping, key urban MNCH decision-making actors at both national and
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54 local levels will be engaged to help identify potential users for UHA. This group will constitute
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our study respondents and training participants. When determining sample size for qualitative research, Guest et al. propose that a homogenous group of respondents 12 interviews is sufficient for reaching data saturation.[26] It is also asserted that a sample under 20 respondents allows qualitative researchers to establish and maintain effective relationships with study participants, and thus enhances the validity of the research.[27] For these reasons, we will sample 15-16 respondents for each of our activities. The sampling strategy, type and number of respondents for each study activity are provided in table 1.

Table 1 Sampling strategy and sample type for each activity of the study

Activity and focus	Data collection methods	Sampling strategy	Respondent group	Sample size
Task Review (document how MNCH planning and referral decisions are currently made)	KIIs	Opportunistic/ Emergent sampling; Snowball sampling	–Urban health systems actors –National and local government officials –NGO programme managers	16
	Desk review	N/A	N/A	N/A

<p>User Need and User Experience (explore user preferences, task needs and experiences)</p>	<p>IDIs (on user needs)</p>	<p>Opportunistic/ Emergent sampling; Snowball sampling</p>	<p>–Policy makers within the MOHFW –Members of the Urban Health Cell of MOLGRDC –Managers at City Corporations –NGO programme managers</p>	<p>16</p>
<p>Policy Engagement (understand interactions between content, context, actors and processes of policy advocacy and entry points for sustainable</p>	<p>KIIs</p>	<p>Opportunistic/ emergent sampling; Snowball sampling</p>	<p>–Urban health systems actors –National and local government officials –NGO programme managers</p>	<p>15</p>
<p>incorporation of ICT into health systems)</p>	<p>Desk review (urban health and ICT related policies)</p>	<p>N/A</p>	<p>N/A</p>	<p>N/A</p>

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3 ICT, Information Communication and Technology; IDI, In-depth Interviews; KII, Key
4 Informant Interviews; MNCH, Maternal, newborn and child health; MOHFW, Ministry of
5 Health and Family Welfare; MOLGRDC, Ministry of Local Government, Rural Development
6 and Cooperatives.
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15 **Implementation procedure of the pilot**

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17 The study implementation is envisaged to begin with stakeholder sensitization and partnership-
18 building with government. This is critical because the research will work closely with the
19 government health system in urban areas. In addition, an intervention will be conducted
20 consisting of capacity building sessions around the use of the UHA for government and other
21 urban health planners and managers. Details of these activities are provided below.
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31 *Stakeholder consultation and engagement:* Two stakeholder consultation workshops will be
32 carried out to identify and engage key stakeholders to create research buy-in and to begin the
33 process of UHA advocacy. Detailed information on identification and mapping of stakeholders
34 has been described in the data collection section. Ideas will be generated for uptake, regular use,
35 and update of UHA.
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45 *Partnership development with Government:* Implementation partnerships with the Management
46 Information System (MIS) of the DGHS, MOHFW will be developed and a Memorandum of
47 Understanding will be signed between icddr,b and DGHS. Permission letters will also be
48 obtained from mayors of CCs and municipalities.
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3 *Development of training materials:* A training manual on Urban Health Atlas (UHA) will be
4 prepared to guide UHA capacity building workshops including case studies, guidelines for group
5 work and hand-on activities, pre-test/post-test questionnaires, etc.
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12 *UHA workshops:* In each study site, a 2-day UHA workshop, and subsequent 1 day refresher
13 course, will be organized with a selected group of health workers and managers drawn from local
14 government, and NGOs. Institutional agreements and permissions will be sought in advance
15 from local government institutions and the health ministry as appropriate. Training sessions will
16 provide an introduction to current urban health challenges, followed by an overview and
17 demonstration of the Urban Health Atlas and its functions. Hands on training, group work and
18 case studies will be undertaken to familiarize users with UHA and to get their feedback on how it
19 might be improved to better meet their needs.
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31 **Data collection**

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33 Interviews will be conducted by an experienced group of researchers trained in qualitative
34 interviewing including a mixed method expert, two software programmers, one GIS expert and
35 an economist. The team will begin data collection in Dhaka, then move to the municipalities. A
36 period of rapport building with key stakeholders in each study site will be critical to the success
37 of this research given known difficulties in accessing the Government sector. Utilizing existing
38 networks and negotiation skills will be especially important in opening doors and initiating
39 discussion. The UHA tool will be assessed for impact on MNCH decision-making and outcomes.
40 It is unlikely, however, that these effects would be apparent within three years of
41 implementation. Thus, success of the tool will be determined based on user experiences as
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3 specified by WHO PATH Toolkit i.e. better indicators for strategic planning, day-to-day
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5 decision-making, control and oversight, and reduced administrative burden.
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10 *Data collection methods for objective 1*

11 To address objective 1, assessment of information needs and task review analysis will be done by
12
13 desk review, in-depth interviews and click streams. Guidelines for qualitative interviews will be
14
15 developed based on the WHO PATH toolkit's questions to measure success. Three qualitative
16
17 research activities are envisaged to address this objective:
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- 24 1. Key informant interviews (KIIs) with urban health system actors along with desk reviews
25 to understand and document how MNCH planning and referral decisions are currently
26
27 made.
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- 30 2. In-depth interviews (IDIs) with potential UHA users to explore user preferences and task
31
32 needs to refine the tool in advance of training.
33
34
- 35 3. IDIs with UHA users to understand their experiences and to document challenges and
36
37 successes of using UHA for MNCH service decision-making during training and one- &
38
39 three-months post-training.
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44 In addition to qualitative assessments of user experiences, quantitative assessments of how
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46 different stakeholders are using data remotely will be made through (i) User's click streams; (ii)
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48 Task time devoted to different applications. Written feedback through online tools (i.e. Google
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50 Analytics) that facilitate remote testing will also be collected to generate more user-friendly
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52 functions that meet user needs.
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Data collection methods for objective 2

To identify entry points that will facilitate broader use of geo-referenced facility information and its regular update, stakeholder mapping, policy mapping using desk review, KIIs, and stakeholder consultation workshop will be conducted. Guidelines for qualitative interviews will be developed using the policy engagement framework as a guide. Policy and programmatic entry points for the broader use and update of facility information, stakeholder analysis will be undertaken using Policy Engagement Framework as a guide. Stakeholders are identified as persons, groups, organization members or systems that affect or can be affected by a project/program/activity. Stakeholder analysis is an approach for generating knowledge about roles, behavior, inter-relation and intention of associated actors and their influence in implementation processes of a program or policy.[28] Given the importance of stakeholder satisfaction and support for the success of any program,[29,30] incorporating stakeholders' perspectives and needs is a critical step in gaining ownership around an ICT innovation like UHA and its incorporation into routine information systems, and use for decision-making. The following qualitative methods will be used to fulfill objective 2:

1. Stakeholder mapping including the identification and listing of stakeholder groups involved in urban health based on available literature and expert opinion.
2. A semi-structured guideline will be used to collect information during stakeholder consultation workshops to explore their respective interests, roles and responsibilities in urban health, their information needs, and perceptions of how they can contribute to institutionalizing UHA.

3. KIIs along with desk reviews will be undertaken to understand the processes of current health policy-making mechanisms and what other policies affect the integration of ICT in health.

Data collection methods for objective 3

To estimate cost of bringing facility listing into the government information system the total cost of ownership for UHA development and implementation will be estimated using an ingredient approach. Data will be collected through structured questionnaire, document review and KII. Cost will be estimated based on supply side aspects. The budget matrix will be developed with cost drivers proposed in the WHO PATH toolkit.

The cost for development and implementation of Urban Health Atlas (UHA) tools, coordination, and engagement of city corporations and DGHS will be estimated including both financial costs and economic costs of the program. Financial costs represent the actual expenditures on goods and services purchased. Economic costs include the estimated value of goods or services for which either there are no financial transactions or the price of a specific good did not reflect the cost of using it productively elsewhere.[31] The cost will be separated for start-up cost and implementation cost. The implementation cost comprises the costs required to run and maintain the ICT tools while executing intervention.[32]

All supply-side inputs will be identified, quantified and valued through a facility-level inventory, record reviews and key informant interviews. Both fixed cost and variable cost will be captured. Shared cost items, including salary, buildings, furniture, supervision, transportation, and vehicles, will be identified through observation and interviews of relevant personnel. Shared

costs will be apportioned by proportion of the time-involvement of the relevant items (i.e. office rent, common vehicle) to different activities. The time of volunteers will be transformed into costs by using the minimum wage level of manual workers in Bangladesh. There are some examples of components included in ingredient approaches (table 2):[32,33]

Table 2 Components included in ingredient approaches for cost

Method Name	Methodology	Inputs	Activities
Ingredients approach	Quantities x price, personnel, percentage use	Personnel, ICT tools, vehicles	Personnel , ICT tools, vehicles

ICT, Information Communication and Technology.

To identify activities of the UHA tool implementation and their related inputs, a review of program documents and interviews with relevant personnel will be conducted. The unit price/salary information will be collected from responsible program management. In case of missing unit price of any items, the market price of those items will be collected. Semi-structured checklists for cost data collection will be developed considering the program context and using WHO PATH toolkit as a guiding framework. The budget matrix will be completed with help from key personnel associated with costing and budgeting identified during the stakeholder mapping and research team's own estimates.

Data analysis

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3 A process flowchart for current decision-making practices will be prepared using the KII and
4 Organizational process reviews. A list of user needs will be made and shared at a stakeholder
5 consultation meeting to identify the most important and feasible functions to be added to UHA.
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12 For *qualitative data*, an outline plan for data analysis will be prepared in advance of research
13 along with a priori codes. These codes, mostly focusing on user experience, will be derived from
14 the WHO PATH toolkit.[18] The analysis will be open to emerging themes as well. All
15 interviews will be recorded provided consent has been obtained, but with simultaneous note
16 taking in case of equipment failure. Data transcription will occur immediately following each
17 interview, followed by translation. Data familiarization will involve reading transcripts
18 repeatedly to surface emerging themes and identify any missed opportunities for further
19 exploration. Transcripts will be coded using ATLAS-ti (version-7.5.7). A team approach to
20 analysis will be employed to minimize individual biases. Inter-coder reliability will be checked.
21 Group discussions of emerging themes and patterns in the data will be tested using data displays
22 that allow more systematic pattern-testing across respondents.
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40 For *stakeholder analysis*, stakeholders' influence, importance and agreement will be explored
41 applying standard techniques and measurement scales mentioned in table 3. A position diagram
42 with level of agreement and level of influence will also be plotted to identify stakeholders who
43 are already committed to work and help institutionalize UHA and those who need to be brought
44 into agreement.
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Table 3 Operational definitions for stakeholder analysis for policy engagement

Theme	Terms used	Operational definition
Influence, importance and agreement analysis of stakeholders	Level of influence	Stakeholders' influence will be determined according to each stakeholder group's perception and views on who is important in terms of urban health care delivery.
	Level of agreement	Stakeholders' agreement will be determined according to how much each stakeholder agreed.
	Level of importance	The stakeholders' importance will be determined according to how important each stakeholder group is to the other groups.
Power and leadership	Overall power	Power of a stakeholder-group will be assessed as compared to all other groups in Bangladeshi urban healthcare delivery system. Power of stakeholders will be measured as the product of multiplication of influence and importance.
	Relative position	Relative position of each stakeholder group will be assessed by comparing one group's position to other groups in broader scenario.
Relative positions of	Drivers	Stakeholders who have high level of importance as well as high level of influence on public sector health care delivery system

stakeholders	Supporters	Stakeholders who have high level of importance but low level of influence on urban healthcare delivery system
	Bystanders	Stakeholders who have low level of importance and low level of influence on urban healthcare delivery system
	Abstainers	Stakeholders who have no influence and no importance on urban healthcare delivery system
	Blockers	Stakeholders who have low level of importance but high level of influence on urban healthcare care delivery system.

For the *policy engagement analysis*, KIIs with stakeholders will be examined to understand interactions between actors, content, context and processes with respect to ICT policy uptake, with a view to identifying entry points for policy advocacy and the sustainable incorporation of ICT in health systems. Interviews will be analyzed using a priori codes drawn from the Policy Engagement Framework. Of additional interest in this analysis is understanding the mechanisms and processes of health policy development and how other policies may be important in efforts to integrate ICT into health systems. Based on these insights, a Health Policy for ICT process flowchart will be prepared. According to the policy engagement framework we will also seek information on how context is considered and dealt with when policies are formed and what processes need to be changed to more effectively integrate UHA into the system.[22]

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5 For *quantitative data*, simple descriptive analysis will be performed to show user rates over time.
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8 The set of parameters to be analyzed are: number of users who accessed UHA, type of user,
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10 scope of UHA use, and types of problems faced. For data analysis, software like MS Excel and
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12 STATA will be used as appropriate.
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17 The *cost* of implementing UHA will be estimated using a direct approach. Average cost for each
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19 activity will be calculated. All supply-side inputs will be identified, quantified and valued
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21 through record review and KIIs. Shared cost items, including salary, buildings, furniture,
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23 supervision, transportation, and vehicles will be identified through observation and interviews of
24
25 relevant personnel. By considering the nature of inputs, these will be categorized into capital,
26
27 recurrent as well as fixed and variable cost items. Shared costs will be apportioned by
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29 proportion of the time-involvement of the relevant items (office rent, common vehicle) to
30
31 different activities. Inputs will be identified using discussion with relevant personnel,
32
33 observation and record review. If unavailable, market prices will be applied to estimate costs.
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37 The capital items will be annualized, and common costs will be apportioned as per requirement.
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39 Annual values of capital items will be estimated from their expected useful life years and
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41 annuitization will be done using 3% discounting rate whenever applicable.[34] The study will
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43 allocate the cost for shared items (e.g. office space, appliances) by using actual utilization of
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45 items for this activity. Utilization information for shared items will be collected from responsible
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47 project staff.
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51 Finally, the cost for shared items will be estimated by multiplying percentage-use information
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53 with the total cost of the items. Total cost will be calculated by summing up the start-up and
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3 implementation costs. Relative contribution of start-up and implementation cost will be
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5 calculated. The cost-drivers in each activity will be identified considering the larger share of total
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7 cost.
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12 **Process documentation**

14 In addition to all these activities, the study investigators will systematically document
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16 implementation processes for policy uptake and institutionalization of UHA, focusing
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18 particularly on contextual factors and their influence on implementation using a process
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20 documentation template. Process documentation of this “pilot phase” of UHA institutionalization
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22 will generate supporting knowledge to be applied the phases of scale-up and sustain, as specified
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24 in the WHO/PATH toolkit.
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31 **Patient and public involvement**

33 There will be no direct patient or public involvement in this implementation research. However,
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35 a Technical Advisory Group (TAG) will be formulated for project governance, which will
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37 consist of representatives from Government, development partners, NGOs, academicians and
38
39 senior researchers and urban health actors. Regular meetings will be held with partners and staff
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41 for problem solving. At the end of the study, the TAG will comment on the study findings and
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43 contribute to the dissemination plan.
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49 **Ethics**

51 This study has received approval from the Research Review Committee (RRC) and the Ethical
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53 Review Committee (ERC) of icddr,b, both of which provided a thorough and critical review of
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3 the protocol's technical and ethical aspects. Participants will be asked for written consent prior
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5 interviewing and will remain anonymous and unidentifiable. Tape recorders will be used to
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7 record discussions but only after obtaining consent. All other form of data will be kept in locked
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9 storage, or controlled access folders, allowing only investigators of the study and members of the
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11 ERC of icddr,b to access information, if needed.
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16 17 **Dissemination**

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19 Findings from this research will be disseminated at various levels to develop interest and support
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21 from a wide variety of audiences i.e. public, private, NGO, civil society and donors. In doing so,
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23 we hope to build a diverse constituency of individuals and organizations willing and able to
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25 translate evidence yielded by the study, into policy action.
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31 *Local dissemination:* Findings will be presented to relevant local administrators, development
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33 partners and NGOs and other relevant parties (local health practitioners), researchers.
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38 *National dissemination:* A series of interactive workshops and briefing sessions with various
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40 stakeholders will be arranged to create linkages with national fora. The main aim will be to
41
42 translate findings in a more visual and engaging format; i.e. research briefs and interactive
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44 project brochures, to reach a range of stakeholders.
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49 *International dissemination:* This will include publishing findings in peer-reviewed journals and
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51 presenting in scientific forums, conferences and symposiums, and linking with international
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53 learning platforms. The main objective is to contribute to global knowledge about context
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3 specific strategies to incorporate ICTs into health systems, and challenges that must be
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5 anticipated.
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10 **CONCLUSIONS**

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12 The proposed study seeks to understand the utility and processes by which the visualization of
13
14 geo-referenced health facility information can contribute towards improving MNCH services in
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16 terms of strategy development, decision-making and oversight, with a special focus on the urban
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18 poor, and how best to approach the existing system for its institutionalization. The results from
19
20 this study will inform efforts to scale-up the generation and application of facility listing data in
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22 urban areas nationwide. Beyond Bangladesh, this study is also expected to provide valuable
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24 guidance on how to generate user buy-in, and policy uptake necessary to introduce, scale-up, and
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26 sustain MNCH-related ICTs in similar LMICs. Once UHA becomes institutionalized, future
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28 research plans include evaluation of the use of the UHA and its impact on maternal and child
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30 health outcomes in urban areas in Bangladesh through longitudinal studies.
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3 **Figure 1.** Modified conceptual framework for Information Communication and Technology
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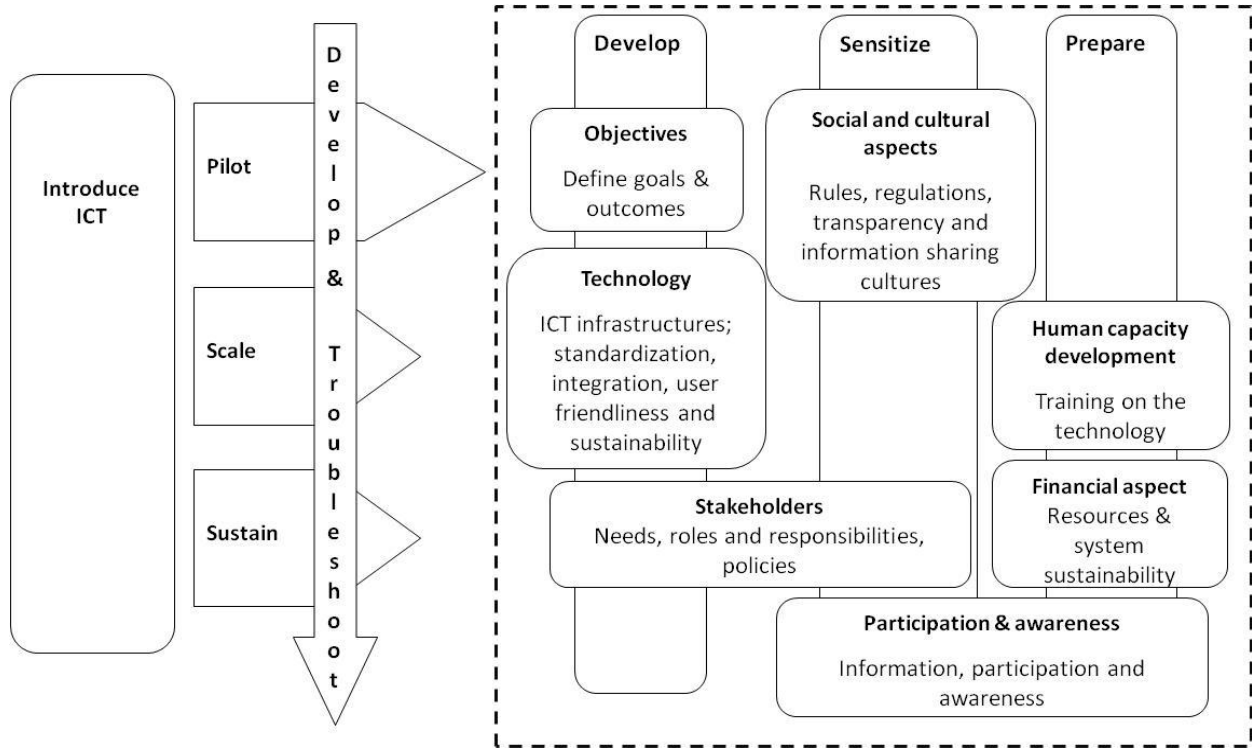


Figure 1. Modified Conceptual framework for Information Communication and Technology (ICT) implementation in developing countries

Reduced MNC morbidity and mortality

Appropriate and timely MNC healthcare

Improved MNCH service coverage

Improved MNCH service quality

Purpose: To improve urban MNCH service planning and monitoring

Input:

- 1. Health facility data visualization tool

Constraints:

- 1. Capacity to use and update
- 2. No ownership within the health system

Activities:

- 1. Provide training
- 2. Identify barriers in uptake
- 3. Costing exercise

Outputs:

- 1. UHA trained personnel in the MoH, MOLGRDC, CC, NGO
- 2. List of changes to improve usability
- 3. Recommendations for policy changes need to facilitate implementation and uptake

Effects:

- 1. Regular use of UHA for planning decisions by health facility managers and policy makers
- 2. Better monitoring of health service providers
- 3. Optimum use of health resources

Context: Heterogenous health systems; poor co-ordination and monitoring; poor quality of healthcare; gaps in urban health service; poor availability and affordability of healthcare for the urban poor

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Making Information and Communications Technologies (ICTs) work for health: protocol for a mixed-methods study exploring processes for institutionalizing geo-referenced health information systems to strengthen Maternal Neonatal and Child Health (MNCH) service planning, referral and oversight in urban Bangladesh

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Title: Making Information and Communications Technologies (ICTs) work for health: protocol for a mixed-methods study exploring processes for institutionalizing geo-referenced health information systems to strengthen Maternal Neonatal and Child Health (MNCH) service planning, referral and oversight in urban Bangladesh

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30 *Author Contributions*

31 RI & AA conceptualized the study. RI & AA prepared the first draft of the manuscript. SMH,
32 RA, DSB and SS revised the manuscript. RI & AA reviewed critically for important intellectual
33 content; SS revised the version submitted with inputs from all other co-authors.
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3 *Competing interests*
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5 The authors declare no competing interests.
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19 *Study period*
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26 *Data statement section*
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28 Data will be handled according to the principles of the icddr,b policies and guidelines of the
29 International Development Research Centre, Canada.
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Abbreviations

ADB	Asian Development Bank
CCs	City Corporations
DGHS	Directorate General of Health Services
ERC	Ethical Review Committee
GIS	Geographic Information System
HMIS	Health Management Information System
ICT	Information Communication and Technology
IDI	In-depth Interviews
KII	Key Informant Interviews
LMICs	Low and Middle Income Countries
MNCH	Maternal, newborn and child health
MOHFW	Ministry of Health and Family Welfare
MOLGRDC	Ministry of Local Government, Rural Development and Cooperatives
NGOs	Non-Government Organizations
PHC	Primary Health Care
RRC	Research Review Committee
SDGs	Sustainable Development Goals
UHA	Urban Health Atlas
UHC	Universal Health Coverage
WHO	World Health Organization

ABSTRACT

Introduction: Disparities in health outcomes and access to maternal neonatal and child health (MNCH) are apparent among urban poor compared to national, rural or urban averages. A fundamental first step in addressing inequities in MNCH services is, knowing what services exist in urban areas, where these are located, who provides them, and who uses them. This study aims to institutionalize the Urban Health Atlas (UHA) - a novel ICT tool - to strengthen health service delivery and oversight and generate critical evidence to inform health policy and planning in urban Bangladesh.

Methods and analysis: This mixed-method implementation research will be conducted in four purposively selected urban sites representing larger and smaller cities. Research activities will include an assessment of information needs and task review analysis of information users, stakeholder mapping, and cost estimation. To document stakeholder perceptions and experiences, Key Informant Interviews (KIIs) and In-depth Interviews (IDIs) will be conducted along with desk reviews to understand MNCH planning and referral decisions. The UHA will be refined to increase responsiveness to user needs and capacities, and hands-on training will be provided to health managers. Cost estimation will be conducted to assess the financial implications of UHA uptake and scale-up. Systematic documentation of the implementation process will be undertaken. Policy decision-making and ICT health policy process flowcharts will be prepared using desk reviews and qualitative interviews. Thematic analysis of qualitative data will involve both emergent and a priori coding guided by WHO PATH toolkit and Policy Engagement Framework. Stakeholder analysis will apply standard techniques and measurement scales. Descriptive analysis of quantitative data and cost estimation analysis will also be performed.

Ethics and dissemination: The study has been approved by the Institutional Review Board of icddr,b (# PR-16057). Study findings will be disseminated through national and international workshops, conferences, policy briefs and peer-reviewed publications.

Keywords

Urban health, maternal, neonatal and child health, information communication and technology, geographic information systems, health management information systems, Bangladesh.

Article Summary

Strengths and limitations of this study

- This mixed method implementation research is among the first in Bangladesh to explore processes for institutionalizing geo-referenced health information systems to strengthen MNCH service planning, referral, and oversight in urban areas.
- The proposed research will generate knowledge to enhance understanding of how geo-referenced health facility information can inform MNCH service planning and decision making.
- This study is expected to provide valuable guidance beyond Bangladesh's HMIS on how to generate user buy-in and policy uptake necessary to introduce MNCH-related ICTs in developing country contexts.

INTRODUCTION

Bangladesh has embraced the Sustainable Development Goal-3 (SDGs) of achieving universal health coverage by 2030,[1] however, challenges related to rapid population growth, pluralistic health systems, and lack of governance, among others, are substantial.[2] Although Bangladesh has made extraordinary progress in reducing maternal and child mortality,[3] there are significant disparities in health-related outcomes and access to maternal neonatal and child health (MNCH) services stratified along both socioeconomic and geographic dimensions. Health indicators are far worse in urban slums than both non-slum urban areas and the national average.[4] Nationally, the mortality rate for children under five years of age is 65 per 1,000 live births and 49 per 1,000 live births in rural areas while the rate is 81 per 1000 live births among urban slum residents.[4, 5] Undergoing rapid urbanization, the country is projected to become over 50% urban by 2040, with almost one-third of urban residents living in slums.[6] Persistent inequities in key MNCH indicators in urban areas highlight the need to focus on issues of service coverage, access, quality and timely and appropriate referral as urgent policy priorities.

The Bangladesh urban health system is a smorgasbord of service providers characterized by inadequate coordination and regulation, and geographic and socioeconomic inequities in healthcare access.[7, 8] Several reasons have been proposed for inefficiencies in the system including poor planning and management capacity, weak coordination among the authorities, lack of clear, separate roles and responsibilities for the various authorities, service coverage gaps, and human resource management issues.[9, 10] Of particular concern in urban areas is the lack of adequate public primary care infrastructure and services which disproportionately impacts the urban poor, and poses significant challenges to the country's aspirations to meet the goal of Universal Health Coverage by 2030.[11] One consequence of limited formal primary healthcare

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3 services in urban areas[12] is the emergence of the private sector in health including the
4 proliferation of informal providers such as pharmacies on which many of the urban poor rely.
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6 The formal private sector is equally massive, accounting for 80% of over 3500 hospitals in
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8 Bangladesh, and an even greater percentage in urban areas. Lack of regulation of this sector has
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10 resulted in concerns about quality of care and financial accessibility, especially for the urban
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12 poor.[10]
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16 A fundamental first step in addressing inequities in urban healthcare access is an in-depth
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18 understanding of what services exist, their location, who provides them, and who utilizes them.
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20 A strong health management information system (HMIS), an essential component of sound
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22 programme development and implementation. Enabling the use of data for strategic decision-
23
24 making, better governance, institutionalized HMIS systems represent the foundation upon which
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26 improvements in health outcomes can be monitored and greater accountability ensured.[13, 14]
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30 A Master Facility List (MFL) is a crucial constituent of HIS and permits the linkage of sub-
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32 systems within national HIS architecture.[15,16] MFL is advocated by The World Health
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34 Organization (WHO) as an effective means of ensuring better governance including systematic
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36 reporting and monitoring supervision.[17,18] MFLs like UHA are expected to facilitate health
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38 service planning and management through mapping or visualizing the distribution of health
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40 services and resources. It can also assist health service providers in identifying appropriate
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42 referral facilities for patients.[19] These functions can help improve equitable service coverage
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44 and reduce delays in receiving appropriate care, which in turn can impact health outcomes such
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46 as maternal and child mortality among the urban poor. A theory of change is provided in
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48 supplemental file 1.
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3 Realizing the critical role that health information systems play in health management and
4 building on political commitment towards “Digital Bangladesh”, the Bangladesh Directorate
5 General of Health Services (DGHS), Ministry of Health and Family Welfare (MOHFW) is
6 implementing the District Health Information Software-2 (DHIS2) with support from
7 development partners. While the system has been rolled out nationally, information is largely
8 confined to public healthcare facilities. In urban areas, with the exception of large public
9 hospitals and a number of NGOs involved in primary care provision, data are particularly sparse,
10 especially for the massive private sector.
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24 **Urban Health Atlas: A novel ICT tool**

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26 Addressing this information gap, icddr,b has created a geo-referenced health facility database for
27 nine major cities and municipalities across Bangladesh. This dataset consists of a census of all
28 healthcare facilities and the services they provide along with their geo locations.[20] To enable
29 the practical application of this dataset, an Information Communication and Technology (ICT)
30 tool called *Urban Health Atlas* (UHA) was developed (<http://urbanhealthatlas.com>).[21] This
31 GIS-based interactive online tool displays health facility data visually and permits their
32 manipulation for better healthcare planning and decision making. Providing detailed information
33 on the location and services available at public and private health facilities, it allows users to
34 examine gaps and duplication in service provision, assess the coverage of emergency services
35 and the availability of doctors in a 24-hour period, calculate the shortest distance to referral
36 facilities from any location, and determine whether a given facility is licensed and registered.
37 This information is particularly useful in helping healthcare planners and policy makers make
38 informed decisions around the distribution and monitoring of healthcare facilities and services,
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3 and health human resources. For the general public, the tool holds promise in locating a desired
4 healthcare service that is closest in distance and indicating the shortest path to get there.
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7 A key strength of this dataset is its inclusion of private-for-profit healthcare facilities, from
8 pharmacies to hospitals, in addition to public and private not-for-profit healthcare provision. The
9
10 UHA prototype has been demonstrated both nationally and internationally, and generated a great
11 deal of interest and useful feedback. In Bangladesh, its promise has intrigued multiple
12 stakeholder groups, ranging from the Directorate General of Health Services (DGHS)
13 responsible for national healthcare planning, local government officials, private not-for-profit or
14 non-government organizations (NGOs), service providers and development partners. In the
15 context of significant investments in urban health systems strengthening that are in pipeline, and
16 absence of urban data in the country's national health information system (DHIS2), UHA is
17 widely regarded as timely and useful in the context of current urban health planning processes,
18 and many discussions about its formal linkage to and institutionalization within existing health
19 information systems have occurred.
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38 However, due to the complexity of these kind of data, they risk being underutilized for health
39 policy and planning unless specific efforts are attempted to make them more accessible to non-
40 technical, policy and other local level stakeholders.[22] In the context of UHA, these efforts have
41 included making the data available on the DGHS webpage, and organizing dissemination events
42 in city corporations and municipalities. However, beyond anecdotal reports, there is no
43 systematic information on whether the tool is being used by stakeholders, and how it could be
44 improved to better meet their needs. The purpose of this study, therefore, is to pilot and refine the
45 UHA for use in service delivery planning and referral, and by generating evidence on its utility,
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3 inform and strengthen advocacy for and action around its institutionalization into the government
4 system. A focus on MNCH service delivery was chosen to circumscribe the development of
5 training materials, and to clearly delimit the range of stakeholders that should be engaged.
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11 **Study Aims**

12 Three specific aims are identified in seeking to institutionalize the UHA for MNCH service
13 delivery, planning, and referral into the government system:
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- 15 1. To document stakeholder perceptions and experiences in adopting a tool that enables use
16 of health facility information for strategic planning, day-to-day decision-making, control
17 and oversight, and improved administrative efficiency of urban MNCH services.
18
- 19 2. To identify policy and programmatic entry points that will facilitate broader use of geo-
20 referenced health facility information and its regular update.
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- 22 3. To estimate costs associated with bringing geo-referenced facility listing into the
23 government system
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35 **METHODS**

36 This Implementation Research (IR) focuses on the factors and processes that influencing uptake,
37 use and scale-up of ICT tools like UHA. The study will explore barriers in usability,
38 understandability, and utility, as well as policy and other requirements needed to support its
39 systematic implementation in the real world setting of healthcare planning, referral, and
40 oversight. The primary audiences of this research are managers and decision makers in the urban
41 healthcare sector of Bangladesh.
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53 **Study design and participants**

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3 The proposed implementation research employs a mixed method research approach. Mixed-
4 method research is a widely used approach in IR.[23] We will assess the uptake of UHA by the
5 MNCH-related planners and decision makers over a 3-year period from 2016-2019. The specific
6 IR variables to be assessed are adoption, appropriateness, feasibility, and implementation cost
7 [23]. Many IR frameworks exist, however it is advised to use a framework befitting program
8 parameters [23]. For this reason, we identified a toolkit specific to the development and use of
9 ICT tools and formulated our conceptual framework accordingly. This helped to operationalize
10 the research as an ICT intervention versus a clinical or health service level intervention, while
11 still retaining some of the features of common IR frameworks, including concerns with guided
12 implementation and innovation, sustainability, and stakeholder input.[23]
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17 The WHO PATH toolkit was published by WHO and PATH to guide the introduction and
18 implementation of information and communications technology (ICT) in health information
19 systems.[18] The introduction of a new ICT tool is commonly accompanied by challenges that
20 must be overcome. Before scaling-up, therefore, it is important to conduct rigorous product
21 planning and feasibility testing, and to identify and engage key stakeholders. The toolkit
22 identifies three main phases of an ICT project: pilot, scale, and sustain. In the pilot phase, the
23 phase addressed in this study, a solution (UHA) is developed based on program needs and
24 priorities, and tested on a small-scale to measure outcomes, impacts, and costs, and identify
25 potential improvements. Several other factors influence the introduction of the HMIS in
26 developing countries including planning, stakeholder roles and responsibilities, cultural aspects,
27 human capacity, financial aspects sustainability etc. (see figure 1).[24] The elements of this
28 ICT-informed framework are similar to that of the different phases of the “replicating effective
29 programs framework” used in IR.[25] For instance, stakeholder needs in our framework are
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3 addressed under the identifying implementation barriers step (pre-conditions phase), the
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5 orientation step of the pre-implementation phase is similar to participation and awareness and
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7 financial aspect elements in our framework, and training and technical assistance of the
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9 implementation phases are addressed through the human capacity development component.
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15 In order to explore user perceptions, and policy and programmatic entry points, the policy
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17 engagement framework [22] also will be employed to prospectively analyze policy that
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19 incorporates strategies for change. This framework will confer a systematic approach to the
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21 ongoing collection, analysis and use of political information (e.g. concerning actors, their
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23 interests, institutions, ideas, and policy processes and context) that can alter the balance of power
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25 between those in support of and those resisting change by enabling pro-reformers to intervene
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27 more effectively in the policy process.[22]
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33 **Study sites**

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35 Two city corporations (CCs) – namely Dhaka North City Corporation (DNCC) and Dhaka South
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37 City Corporation (DSCC) – and two municipalities, Jessore and Dinajpur, which have geo-
38
39 referenced health facility data available from previous mapping exercise of icddr,b[21] will be
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41 purposively selected. As smaller cities, Jessore and Dinajpur municipalities present marked
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43 differences from CCs in terms of size, structure, capacity, and challenges posed.
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49 **Sample size**

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52 Through the stakeholder mapping, key urban MNCH decision-making actors at both national and
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54 local levels will be engaged to help identify potential users for UHA. This group will constitute
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our study respondents and training participants. When determining sample size for qualitative research, Guest et al. propose that a homogenous group of respondents 12 interviews is sufficient for reaching data saturation.[26] It is also asserted that a sample under 20 respondents allows qualitative researchers to establish and maintain effective relationships with study participants, and thus enhances the validity of the research.[27] For these reasons, we will sample 15-16 respondents for each of our activities. The sampling strategy, type, and number of respondents for each study activity are provided in table 1.

Table 1 Sampling strategy and sample type for each activity of the study

Activity and focus	Data collection methods	Sampling strategy	Respondent group	Sample size
Task Review (document how MNCH planning and referral decisions are currently made)	KIIs	Opportunistic/ Emergent sampling; Snowball sampling	–Urban health systems actors –National and local government officials –NGO programme managers	16
	Desk review	N/A	N/A	N/A

User Need and	IDIs	Opportunistic/	–Policy makers within	16
User Experience	(on user needs)	Emergent	the MOHFW	
(explore user		sampling;	–Members of the Urban	
preferences, task		Snowball	Health Cell of	
needs and		sampling	MOLGRDC	
experiences)			–Managers at City	
			Corporations	
			–NGO programme	
			managers	
Policy Engagement	KIIs	Opportunistic/	–Urban health systems	15
(understand		emergent	actors	
interactions between		sampling;	–National and local	
content, context,		Snowball	government officials	
actors and processes		sampling	–NGO programme	
of policy advocacy			managers	
and entry points for				
sustainable				
incorporation of ICT	Desk review	N/A	N/A	N/A
into health systems)	(urban health			
	and ICT related			
	policies)			

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3 ICT, Information Communication and Technology; IDI, In-depth Interviews; KII, Key
4 Informant Interviews; MNCH, Maternal, newborn and child health; MOHFW, Ministry of
5 Health and Family Welfare; MOLGRDC, Ministry of Local Government, Rural Development
6 and Cooperatives.
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15 **Implementation procedure of the pilot**

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17 The study implementation is envisaged to begin with stakeholder sensitization and partnership-
18 building with government. This is critical because the research will work closely with the
19 government health system in urban areas. In addition, an intervention will be conducted
20 consisting of capacity building sessions around the use of the UHA for government and other
21 urban health planners and managers. Details of these activities are provided below.
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31 *Stakeholder consultation and engagement:* Two stakeholder consultation workshops will be
32 carried out to identify and engage key stakeholders to create research buy-in and to begin the
33 process of UHA advocacy. Detailed information on identification and mapping of stakeholders
34 has been described in the data collection section. Ideas will be generated for uptake, regular use,
35 and update of UHA.
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45 *Partnership development with Government:* Implementation partnerships with the Management
46 Information System (MIS) of the DGHS, MOHFW will be developed and a Memorandum of
47 Understanding will be signed between icddr,b and DGHS. Permission letters will also be
48 obtained from mayors of CCs and municipalities.
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3 *Development of training materials:* A training manual on Urban Health Atlas (UHA) will be
4 prepared to guide UHA capacity building workshops including case studies, guidelines for group
5 work and hand-on activities, pre-test/post-test questionnaires, etc.
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12 *UHA workshops:* In each study site, a 2-day UHA workshop, and subsequent 1-day refresher
13 course, will be organized with a selected group of health workers and managers drawn from local
14 government, and NGOs. Institutional agreements and permissions will be sought in advance
15 from local government institutions and the health ministry as appropriate. Training sessions will
16 provide an introduction to current urban health challenges, followed by an overview and
17 demonstration of the Urban Health Atlas and its functions. Hands on training, group work and
18 case studies will be undertaken to familiarize users with UHA and to get their feedback on how it
19 might be improved to better meet their needs.
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33 **Data collection**

34 Interviews will be conducted by an experienced group of researchers trained in qualitative
35 interviewing including a mixed method expert, two software programmers, one GIS expert and
36 an economist. The team will begin data collection in Dhaka, then move to the municipalities. A
37 period of rapport building with key stakeholders in each study site will be critical to the success
38 of this research given known difficulties in accessing the Government sector. Utilizing existing
39 networks and negotiation skills will be especially important in opening doors and initiating
40 discussion. The UHA tool will be assessed for impact on MNCH decision-making and outcomes.
41 It is unlikely, however, that these effects would be apparent within three years of
42 implementation. Thus, success of the tool will be determined based on user experiences as
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3 specified by WHO PATH Toolkit i.e. better indicators for strategic planning, day-to-day
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5 decision-making, control and oversight, and reduced administrative burden.
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10 *Data collection methods for objective 1*

11 To address objective 1, assessment of information needs and task review analysis will be done by
12
13 desk review, in-depth interviews and click streams. Guidelines for qualitative interviews will be
14
15 developed based on the WHO PATH toolkit's questions to measure success. Three qualitative
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17 research activities are envisaged to address this objective:
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- 24 1. Key informant interviews (KIIs) with urban health system actors along with desk reviews
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26 to understand and document how MNCH planning and referral decisions are currently
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28 made.
29
- 30 2. In-depth interviews (IDIs) with potential UHA users to explore user preferences and task
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32 needs to refine the tool in advance of training.
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- 35 3. IDIs with UHA users to understand their experiences and to document challenges and
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37 successes of using UHA for MNCH service decision-making during training and one- &
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39 three-months post-training.
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44 In addition to qualitative assessments of user experiences, quantitative assessments of how
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46 different stakeholders are using data remotely will be made through (i) User's click streams; (ii)
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48 Task time devoted to different applications. Written feedback through online tools (i.e. Google
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50 Analytics) that facilitate remote testing will also be collected to generate more user-friendly
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52 functions that meet user needs.
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Data collection methods for objective 2

To identify entry points that will facilitate broader use of geo-referenced facility information and its regular update, stakeholder mapping, policy mapping using desk review, KIIs, and stakeholder consultation workshop will be conducted. Guidelines for qualitative interviews will be developed using the policy engagement framework as a guide. Policy and programmatic entry points for the broader use and update of facility information, stakeholder analysis will be undertaken using Policy Engagement Framework as a guide. Stakeholders are identified as persons, groups, organization members or systems that affect or can be affected by a project/program/activity. Stakeholder analysis is an approach for generating knowledge about roles, behavior, inter-relation and intention of associated actors and their influence in implementation processes of a program or policy.[28] Given the importance of stakeholder satisfaction and support for the success of any program,[29,30] incorporating stakeholders' perspectives and needs is a critical step in gaining ownership around an ICT innovation like UHA and its incorporation into routine information systems, and use for decision-making. The following qualitative methods will be used to fulfill objective 2:

1. Stakeholder mapping including the identification and listing of stakeholder groups involved in urban health based on available literature and expert opinion.
2. A semi-structured guideline will be used to collect information during stakeholder consultation workshops to explore their respective interests, roles and responsibilities in urban health, their information needs, and perceptions of how they can contribute to institutionalizing UHA.

3. KIIs along with desk reviews will be undertaken to understand the processes of current health policy-making mechanisms and what other policies affect the integration of ICT in health.

Data collection methods for objective 3

To estimate cost of bringing facility listing into the government information system the total cost of ownership for UHA development and implementation will be estimated using an ingredient approach. Data will be collected through structured questionnaire, document review and KII. Cost will be estimated based on supply side aspects. The budget matrix will be developed with cost drivers proposed in the WHO PATH toolkit.

The cost for development and implementation of Urban Health Atlas (UHA) tools, coordination, and engagement of city corporations and DGHS will be estimated including both financial costs and economic costs of the program. Financial costs represent the actual expenditures on goods and services purchased. Economic costs include the estimated value of goods or services for which either there are no financial transactions or the price of a specific good did not reflect the cost of using it productively elsewhere.[31] The cost will be separated for start-up cost and implementation cost. The implementation cost comprises the costs required to run and maintain the ICT tools while executing intervention.[32]

All supply-side inputs will be identified, quantified, and valued through a facility-level inventory, record reviews and key informant interviews. Both fixed cost and variable cost will be captured. Shared cost items, including salary, buildings, furniture, supervision, transportation, and vehicles, will be identified through observation and interviews of relevant personnel. Shared

costs will be apportioned by proportion of the time-involvement of the relevant items (i.e. office rent, common vehicle) to different activities. The time of volunteers will be transformed into costs by using the minimum wage level of manual workers in Bangladesh. There are some examples of components included in ingredient approaches (table 2):[32,33]

Table 2 Components included in ingredient approaches for cost

Method Name	Methodology	Inputs	Activities
Ingredients approach	Quantities x price, personnel, percentage use	Personnel, ICT tools, vehicles	Personnel, ICT tools, vehicles

ICT, Information Communication and Technology.

To identify activities of the UHA tool implementation and their related inputs, a review of program documents and interviews with relevant personnel will be conducted. The unit price/salary information will be collected from responsible program management. In case of missing unit price of any items, the market price of those items will be collected. Semi-structured checklists for cost data collection will be developed considering the program context and using WHO PATH toolkit as a guiding framework. The budget matrix will be completed with help from key personnel associated with costing and budgeting identified during the stakeholder mapping and research team's own estimates.

Data analysis

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3 A process flowchart for current decision-making practices will be prepared using the KII and
4 Organizational process reviews. A list of user needs will be made and shared at a stakeholder
5 consultation meeting to identify the most important and feasible functions to be added to UHA.
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12 For *qualitative data*, an outline plan for data analysis will be prepared in advance of research
13 along with a priori codes. These codes, mostly focusing on user experience, will be derived from
14 the WHO PATH toolkit.[18] The analysis will be open to emerging themes as well. All
15 interviews will be recorded provided consent has been obtained, but with simultaneous note
16 taking in case of equipment failure. Data transcription will occur immediately following each
17 interview, followed by translation. Data familiarization will involve reading transcripts
18 repeatedly to surface emerging themes and identify any missed opportunities for further
19 exploration. Transcripts will be coded using ATLAS-ti (version-7.5.7). A team approach to
20 analysis will be employed to minimize individual biases. Inter-coder reliability will be checked.
21 Group discussions of emerging themes and patterns in the data will be tested using data displays
22 that allow more systematic pattern-testing across respondents.
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40 For *stakeholder analysis*, stakeholders' influence, importance, and agreement will be explored
41 applying standard techniques and measurement scales mentioned in table 3. A position diagram
42 with level of agreement and level of influence will also be plotted to identify stakeholders who
43 are already committed to work and help institutionalize UHA and those who need to be brought
44 into agreement.
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Table 3 Operational definitions for stakeholder analysis for policy engagement

Theme	Terms used	Operational definition
Influence, importance and agreement analysis of stakeholders	Level of influence	Stakeholders' influence will be determined according to each stakeholder group's perception and views on who is important in terms of urban health care delivery.
	Level of agreement	Stakeholders' agreement will be determined according to how much each stakeholder agreed.
	Level of importance	The stakeholders' importance will be determined according to how important each stakeholder group is to the other groups.
Power and leadership	Overall power	Power of a stakeholder-group will be assessed as compared to all other groups in Bangladeshi urban healthcare delivery system. Power of stakeholders will be measured as the product of multiplication of influence and importance.
	Relative position	Relative position of each stakeholder group will be assessed by comparing one group's position to other groups in broader scenario.
Relative positions of	Drivers	Stakeholders who have high level of importance as well as high level of influence on public sector health care delivery system

stakeholders	Supporters	Stakeholders who have high level of importance but low level of influence on urban healthcare delivery system
	Bystanders	Stakeholders who have low level of importance and low level of influence on urban healthcare delivery system
	Abstainers	Stakeholders who have no influence and no importance on urban healthcare delivery system
	Blockers	Stakeholders who have low level of importance but high level of influence on urban healthcare care delivery system.

For the *policy engagement analysis*, KIIs with stakeholders will be examined to understand interactions between actors, content, context and processes with respect to ICT policy uptake, with a view to identifying entry points for policy advocacy and the sustainable incorporation of ICT in health systems. Interviews will be analyzed using a priori codes drawn from the Policy Engagement Framework. Of additional interest in this analysis is understanding the mechanisms and processes of health policy development and how other policies may be important in efforts to integrate ICT into health systems. Based on these insights, a Health Policy for ICT process flowchart will be prepared. According to the policy engagement framework we will also seek information on how context is considered and dealt with when policies are formed and what processes need to be changed to more effectively integrate UHA into the system.[22]

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5 For *quantitative data*, simple descriptive analysis will be performed to show user rates over time.
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8 The set of parameters to be analyzed are: number of users who accessed UHA, type of user,
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10 scope of UHA use, and types of problems faced. For data analysis, software like MS Excel and
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12 STATA will be used as appropriate.
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17 The *cost* of implementing UHA will be estimated using a direct approach. Average cost for each
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19 activity will be calculated. All supply-side inputs will be identified, quantified, and valued
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21 through record review and KIIs. Shared cost items, including salary, buildings, furniture,
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23 supervision, transportation, and vehicles will be identified through observation and interviews of
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25 relevant personnel. By considering the nature of inputs, these will be categorized into capital,
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27 recurrent as well as fixed and variable cost items. Shared costs will be apportioned by
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29 proportion of the time-involvement of the relevant items (office rent, common vehicle) to
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31 different activities. Inputs will be identified using discussion with relevant personnel,
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33 observation, and record review. If unavailable, market prices will be applied to estimate costs.
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37 The capital items will be annualized, and common costs will be apportioned as per requirement.
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39 Annual values of capital items will be estimated from their expected useful life years and
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41 annuitization will be done using 3% discounting rate whenever applicable.[34] The study will
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43 allocate the cost for shared items (e.g. office space, appliances) by using actual utilization of
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45 items for this activity. Utilization information for shared items will be collected from responsible
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47 project staff.
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51 Finally, the cost for shared items will be estimated by multiplying percentage-use information
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53 with the total cost of the items. Total cost will be calculated by summing up the start-up and
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3 implementation costs. Relative contribution of start-up and implementation cost will be
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5 calculated. The cost-drivers in each activity will be identified considering the larger share of total
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7 cost.
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12 **Process documentation**

14 In addition to all these activities, the study investigators will systematically document
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16 implementation processes for policy uptake and institutionalization of UHA, focusing
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18 particularly on contextual factors and their influence on implementation using a process
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20 documentation template. Process documentation of this “pilot phase” of UHA institutionalization
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22 will generate supporting knowledge to be applied the phases of scale-up and sustain, as specified
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24 in the WHO/PATH toolkit.
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31 **Patient and public involvement**

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33 There will be no direct patient or public involvement in this implementation research. However,
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35 a Technical Advisory Group (TAG) will be formulated for project governance, which will
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37 consist of representatives from Government, development partners, NGOs, academicians and
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39 senior researchers and urban health actors. Regular meetings will be held with partners and staff
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41 for problem solving. At the end of the study, the TAG will comment on the study findings and
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43 contribute to the dissemination plan.
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49 **Ethics and Dissemination**

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51 The institutional review board of icddr,b is comprised of two committees: the Research Review
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53 Committee (RRC) and Ethical Review Committee (ERC). This study has received approval from
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3 both of the committees, which provided a thorough and critical review of the protocol's technical
4 and ethical aspects. Participants will be asked for written consent prior interviewing and will
5 remain anonymous and unidentifiable. Tape recorders will be used to record discussions but only
6 after obtaining consent. All other form of data will be kept in locked storage, or controlled access
7 folders, allowing only investigators of the study and members of the ERC of icddr,b to access
8 information, if needed.
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19 Findings from this research will be disseminated at various levels to develop interest and support
20 from a wide variety of audiences i.e. public, private, NGO, civil society, and donors. In doing
21 so, we hope to build a diverse constituency of individuals and organizations willing and able to
22 translate evidence yielded by the study, into policy action.
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31 *Local dissemination:* Findings will be presented to relevant local administrators, development
32 partners and NGOs and other relevant parties (local health practitioners), researchers.
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38 *National dissemination:* A series of interactive workshops and briefing sessions with various
39 stakeholders will be arranged to create linkages with national fora. The main aim will be to
40 translate findings in a more visual and engaging formats, i.e. research briefs and interactive
41 project brochures, to reach a range of stakeholders.
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49 *International dissemination:* This will include publishing findings in peer-reviewed journals and
50 presenting in scientific forums, conferences, and symposiums, and linking with international
51 learning platforms. The main objective is to contribute to global knowledge about context
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3 specific strategies to incorporate ICTs into health systems, and challenges that must be
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5 anticipated for policy uptake necessary to introduce, scale up and sustain MNCH related ICTs in
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7 similar LMICs.
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For peer review only

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3 **Figure 1.** Modified conceptual framework for Information Communication and Technology
4 (ICT) implementation in developing countries
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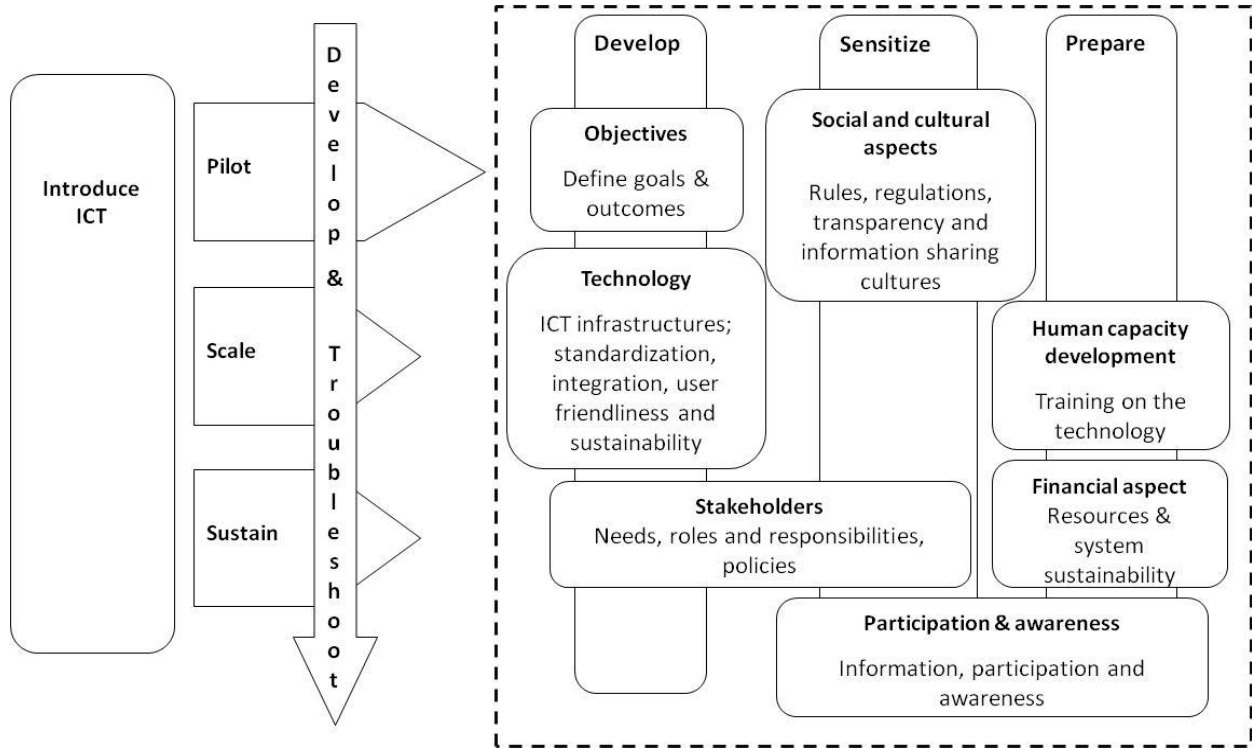


Figure 1. Modified Conceptual framework for Information Communication and Technology (ICT) implementation in developing countries

Reduced MNC morbidity and mortality

Appropriate and timely MNC healthcare

Improved MNCH service coverage

Improved MNCH service quality

Purpose: To improve urban MNCH service planning and monitoring

Input:

1. Health facility data visualization tool

Constraints:

1. Capacity to use and update
2. No ownership within the health system

Activities:

1. Provide training
2. Identify barriers in uptake
3. Costing exercise

Outputs:

1. UHA trained personnel in the MoH, MOLGRDC, CC, NGO
2. List of changes to improve usability
3. Recommendations for policy changes need to facilitate implementation and uptake

Effects:

1. Regular use of UHA for planning decisions by health facility managers and policy makers
2. Better monitoring of health service providers
3. Optimum use of health resources

Context: Heterogenous health systems; poor co-ordination and monitoring; poor quality of healthcare; gaps in urban health service; poor availability and affordability of healthcare for the urban poor

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BMJ Open

Making Information and Communications Technologies (ICTs) work for health: protocol for a mixed-methods study exploring processes for institutionalizing geo-referenced health information systems to strengthen Maternal Neonatal and Child Health (MNCH) service planning, referral and oversight in urban Bangladesh

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Title: Making Information and Communications Technologies (ICTs) work for health: protocol for a mixed-methods study exploring processes for institutionalizing geo-referenced health information systems to strengthen Maternal Neonatal and Child Health (MNCH) service planning, referral and oversight in urban Bangladesh

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30 *Author Contributions*

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32 RI & AA conceptualized the study. RI & AA prepared the first draft of the manuscript. SMH,
33
34 RA, DSB and SS revised the manuscript. RI & AA reviewed critically for important intellectual
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36 content; SS revised the version submitted with inputs from all other co-authors.

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19 *Study period*
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21 2016-2019
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26 *Data statement section*
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28 Data will be handled according to the principles of the icddr,b policies and guidelines of the
29 International Development Research Centre, Canada. Since this is a protocol paper, no data are
30 available.
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Abbreviations

ADB	Asian Development Bank
CCs	City Corporations
DGHS	Directorate General of Health Services
ERC	Ethical Review Committee
GIS	Geographic Information System
HMIS	Health Management Information System
ICT	Information Communication and Technology
IDI	In-depth Interviews
KII	Key Informant Interviews
LMICs	Low and Middle Income Countries
MNCH	Maternal, newborn and child health
MOHFW	Ministry of Health and Family Welfare
MOLGRDC	Ministry of Local Government, Rural Development and Cooperatives
NGOs	Non-Government Organizations
PHC	Primary Health Care
RRC	Research Review Committee
SDGs	Sustainable Development Goals
UHA	Urban Health Atlas
UHC	Universal Health Coverage
WHO	World Health Organization

ABSTRACT

Introduction: Disparities in health outcomes and access to maternal neonatal and child health (MNCH) are apparent among urban poor compared to national, rural or urban averages. A fundamental first step in addressing inequities in MNCH services is, knowing what services exist in urban areas, where these are located, who provides them, and who uses them. This study aims to institutionalize the Urban Health Atlas (UHA) - a novel ICT tool - to strengthen health service delivery and oversight and generate critical evidence to inform health policy and planning in urban Bangladesh.

Methods and analysis: This mixed-method implementation research will be conducted in four purposively selected urban sites representing larger and smaller cities. Research activities will include an assessment of information needs and task review analysis of information users, stakeholder mapping, and cost estimation. To document stakeholder perceptions and experiences, Key Informant Interviews (KIIs) and In-depth Interviews (IDIs) will be conducted along with desk reviews to understand MNCH planning and referral decisions. The UHA will be refined to increase responsiveness to user needs and capacities, and hands-on training will be provided to health managers. Cost estimation will be conducted to assess the financial implications of UHA uptake and scale-up. Systematic documentation of the implementation process will be undertaken. Policy decision-making and ICT health policy process flowcharts will be prepared using desk reviews and qualitative interviews. Thematic analysis of qualitative data will involve both emergent and a priori coding guided by WHO PATH toolkit and Policy Engagement Framework. Stakeholder analysis will apply standard techniques and measurement scales. Descriptive analysis of quantitative data and cost estimation analysis will also be performed.

Ethics and dissemination: The study has been approved by the Institutional Review Board of icddr,b (# PR-16057). Study findings will be disseminated through national and international workshops, conferences, policy briefs and peer-reviewed publications.

Keywords

Urban health, maternal, neonatal and child health, information communication and technology, geographic information systems, health management information systems, Bangladesh.

Article Summary

Strengths and limitations of this study

- This mixed method implementation research is among the first in Bangladesh to explore processes for institutionalizing geo-referenced health information systems to strengthen MNCH service planning, referral, and oversight in urban areas.
- A conceptual framework specific to ICT tools and their implementation has been developed to guide the research.
- Implementation partnership with the Government will be established to ensure post-implementation maintenance of the geo-referenced health information system.
- Acknowledging the potential contribution of patients and civil society groups to ICT uptake, these groups are not engaged in the health planning exercise for logistic reasons.

INTRODUCTION

Bangladesh has embraced the Sustainable Development Goal-3 (SDGs) of achieving universal health coverage by 2030,[1] however, challenges related to rapid population growth, pluralistic health systems, and lack of governance, among others, are substantial.[2] Although Bangladesh has made extraordinary progress in reducing maternal and child mortality,[3] there are significant disparities in health-related outcomes and access to maternal neonatal and child health (MNCH) services stratified along both socioeconomic and geographic dimensions. Health indicators are far worse in urban slums than both non-slum urban areas and the national average.[4] Nationally, the mortality rate for children under five years of age is 65 per 1,000 live births and 49 per 1,000 live births in rural areas while the rate is 81 per 1000 live births among urban slum residents.[4, 5] Undergoing rapid urbanization, the country is projected to become over 50% urban by 2040, with almost one-third of urban residents living in slums.[6] Persistent inequities in key MNCH indicators in urban areas highlight the need to focus on issues of service coverage, access, quality and timely and appropriate referral as urgent policy priorities.

The Bangladesh urban health system is a smorgasbord of service providers characterized by inadequate coordination and regulation, and geographic and socioeconomic inequities in healthcare access.[7, 8] Several reasons have been proposed for inefficiencies in the system including poor planning and management capacity, weak coordination among the authorities, lack of clear, separate roles and responsibilities for the various authorities, service coverage gaps, and human resource management issues.[9, 10] Of particular concern in urban areas is the lack of adequate public primary care infrastructure and services which disproportionately impacts the urban poor, and poses significant challenges to the country's aspirations to meet the goal of Universal Health Coverage by 2030.[11] One consequence of limited formal primary healthcare

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3 services in urban areas[12] is the emergence of the private sector in health including the
4 proliferation of informal providers such as pharmacies on which many of the urban poor rely.
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6 The formal private sector is equally massive, accounting for 80% of over 3500 hospitals in
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8 Bangladesh, and an even greater percentage in urban areas. Lack of regulation of this sector has
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10 resulted in concerns about quality of care and financial accessibility, especially for the urban
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12 poor.[10]
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16 A fundamental first step in addressing inequities in urban healthcare access is an in-depth
17
18 understanding of what services exist, their location, who provides them, and who utilizes them.
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20 A strong health management information system (HMIS), an essential component of sound
21
22 programme development and implementation. Enabling the use of data for strategic decision-
23
24 making, better governance, institutionalized HMIS systems represent the foundation upon which
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26 improvements in health outcomes can be monitored and greater accountability ensured.[13, 14]
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30 A Master Facility List (MFL) is a crucial constituent of HIS and permits the linkage of sub-
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32 systems within national HIS architecture.[15,16] MFL is advocated by The World Health
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34 Organization (WHO) as an effective means of ensuring better governance including systematic
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36 reporting and monitoring supervision.[17,18] MFLs like UHA are expected to facilitate health
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38 service planning and management through mapping or visualizing the distribution of health
39
40 services and resources. It can also assist health service providers in identifying appropriate
41
42 referral facilities for patients.[19] These functions can help improve equitable service coverage
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44 and reduce delays in receiving appropriate care, which in turn can impact health outcomes such
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46 as maternal and child mortality among the urban poor. A theory of change is provided in
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48 supplemental file 1.
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3 Realizing the critical role that health information systems play in health management and
4 building on political commitment towards “Digital Bangladesh”, the Bangladesh Directorate
5 General of Health Services (DGHS), Ministry of Health and Family Welfare (MOHFW) is
6 implementing the District Health Information Software-2 (DHIS2) with support from
7 development partners. While the system has been rolled out nationally, information is largely
8 confined to public healthcare facilities. In urban areas, with the exception of large public
9 hospitals and a number of NGOs involved in primary care provision, data are particularly sparse,
10 especially for the massive private sector.
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24 **Urban Health Atlas: A novel ICT tool**

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26 Addressing this information gap, icddr,b has created a geo-referenced health facility database for
27 nine major cities and municipalities across Bangladesh. This dataset consists of a census of all
28 healthcare facilities and the services they provide along with their geo locations.[20] To enable
29 the practical application of this dataset, an Information Communication and Technology (ICT)
30 tool called *Urban Health Atlas* (UHA) was developed (<http://urbanhealthatlas.com>).[21] This
31 GIS-based interactive online tool displays health facility data visually and permits their
32 manipulation for better healthcare planning and decision making. Providing detailed information
33 on the location and services available at public and private health facilities, it allows users to
34 examine gaps and duplication in service provision, assess the coverage of emergency services
35 and the availability of doctors in a 24-hour period, calculate the shortest distance to referral
36 facilities from any location, and determine whether a given facility is licensed and registered.
37 This information is particularly useful in helping healthcare planners and policy makers make
38 informed decisions around the distribution and monitoring of healthcare facilities and services,
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3 and health human resources. For the general public, the tool holds promise in locating a desired
4 healthcare service that is closest in distance and indicating the shortest path to get there.
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7 A key strength of this dataset is its inclusion of private-for-profit healthcare facilities, from
8 pharmacies to hospitals, in addition to public and private not-for-profit healthcare provision. The
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10 UHA prototype has been demonstrated both nationally and internationally, and generated a great
11 deal of interest and useful feedback. In Bangladesh, its promise has intrigued multiple
12 stakeholder groups, ranging from the Directorate General of Health Services (DGHS)
13 responsible for national healthcare planning, local government officials, private not-for-profit or
14 non-government organizations (NGOs), service providers and development partners. In the
15 context of significant investments in urban health systems strengthening that are in pipeline, and
16 absence of urban data in the country's national health information system (DHIS2), UHA is
17 widely regarded as timely and useful in the context of current urban health planning processes,
18 and many discussions about its formal linkage to and institutionalization within existing health
19 information systems have occurred.
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37 However, due to the complexity of these kind of data, they risk being underutilized for health
38 policy and planning unless specific efforts are attempted to make them more accessible to non-
39 technical, policy and other local level stakeholders.[22] In the context of UHA, these efforts have
40 included making the data available on the DGHS webpage, and organizing dissemination events
41 in city corporations and municipalities. However, beyond anecdotal reports, there is no
42 systematic information on whether the tool is being used by stakeholders, and how it could be
43 improved to better meet their needs. The purpose of this study, therefore, is to pilot and refine the
44 UHA for use in service delivery planning and referral, and by generating evidence on its utility,
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3 inform and strengthen advocacy for and action around its institutionalization into the government
4 system. A focus on MNCH service delivery was chosen to circumscribe the development of
5 training materials, and to clearly delimit the range of stakeholders that should be engaged.
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11 **Study Aims**

12 Three specific aims are identified in seeking to institutionalize the UHA for MNCH service
13 delivery, planning, and referral into the government system:
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- 15 1. To document stakeholder perceptions and experiences in adopting a tool that enables use
16 of health facility information for strategic planning, day-to-day decision-making, control
17 and oversight, and improved administrative efficiency of urban MNCH services.
18
- 19 2. To identify policy and programmatic entry points that will facilitate broader use of geo-
20 referenced health facility information and its regular update.
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- 22 3. To estimate costs associated with bringing geo-referenced facility listing into the
23 government system
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35 **METHODS**

36 This Implementation Research (IR) focuses on the factors and processes that influence uptake,
37 use and scale-up of ICT tools like UHA. The study will explore barriers in usability,
38 understandability, and utility, as well as policy and other requirements needed to support its
39 systematic implementation in the real world setting of healthcare planning, referral, and
40 oversight. The primary audiences of this research are managers and decision makers in the urban
41 healthcare sector of Bangladesh.
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53 **Study design and participants**

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3 The proposed implementation research employs a mixed method research approach. Mixed-
4 method research is a widely used approach in IR.[23] We will assess the uptake of UHA by the
5 MNCH-related planners and decision makers over a 3-year period from 2016-2019. The specific
6 IR variables to be assessed are adoption, appropriateness, feasibility, and implementation cost
7 [23]. Many IR frameworks exist, however it is advised to use a framework befitting program
8 parameters [23]. For this reason, we identified a toolkit specific to the development and use of
9 ICT tools and formulated our conceptual framework accordingly. This helped to operationalize
10 the research as an ICT intervention versus a clinical or health service level intervention, while
11 still retaining some of the features of common IR frameworks, including concerns with guided
12 implementation and innovation, sustainability, and stakeholder input.[23]
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17 The WHO PATH toolkit was published by WHO and PATH to guide the introduction and
18 implementation of information and communications technology (ICT) in health information
19 systems.[18] The introduction of a new ICT tool is commonly accompanied by challenges that
20 must be overcome. Before scaling-up, therefore, it is important to conduct rigorous product
21 planning and feasibility testing, and to identify and engage key stakeholders. The toolkit
22 identifies three main phases of an ICT project: pilot, scale, and sustain. In the pilot phase, the
23 phase addressed in this study, a solution (UHA) is developed based on program needs and
24 priorities, and tested on a small-scale to measure outcomes, impacts, and costs, and identify
25 potential improvements. Several other factors influence the introduction of the HMIS in
26 developing countries including planning, stakeholder roles and responsibilities, cultural aspects,
27 human capacity, financial aspects sustainability etc. (see figure 1).[24] The elements of this
28 ICT-informed framework are similar to that of the different phases of the “replicating effective
29 programs framework” used in IR.[25] For instance, stakeholder needs in our framework are
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3 addressed under the identifying implementation barriers step (pre-conditions phase), the
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5 orientation step of the pre-implementation phase is similar to participation and awareness and
6
7 financial aspect elements in our framework, and training and technical assistance of the
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9 implementation phases are addressed through the human capacity development component.
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15 In order to explore user perceptions, and policy and programmatic entry points, the policy
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17 engagement framework [22] also will be employed to prospectively analyze policy that
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19 incorporates strategies for change. This framework will confer a systematic approach to the
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21 ongoing collection, analysis and use of political information (e.g. concerning actors, their
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23 interests, institutions, ideas, and policy processes and context) that can alter the balance of power
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25 between those in support of and those resisting change by enabling pro-reformers to intervene
26
27 more effectively in the policy process.[22]
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33 **Study sites**

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35 Two city corporations (CCs) – namely Dhaka North City Corporation (DNCC) and Dhaka South
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37 City Corporation (DSCC) – and two municipalities, Jessore and Dinajpur, which have geo-
38
39 referenced health facility data available from previous mapping exercise of icddr,b[21] will be
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41 purposively selected. As smaller cities, Jessore and Dinajpur municipalities present marked
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43 differences from CCs in terms of size, structure, capacity, and challenges posed.
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49 **Sample size**

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52 Through the stakeholder mapping, key urban MNCH decision-making actors at both national and
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54 local levels will be engaged to help identify potential users for UHA. This group will constitute
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our study respondents and training participants. When determining sample size for qualitative research, Guest et al. propose that a homogenous group of respondents 12 interviews is sufficient for reaching data saturation.[26] It is also asserted that a sample under 20 respondents allows qualitative researchers to establish and maintain effective relationships with study participants, and thus enhances the validity of the research.[27] For these reasons, we will sample 15-16 respondents for each of our activities. The sampling strategy, type, and number of respondents for each study activity are provided in table 1.

Table 1 Sampling strategy and sample type for each activity of the study

Activity and focus	Data collection methods	Sampling strategy	Respondent group	Sample size
Task Review (document how MNCH planning and referral decisions are currently made)	KIIs	Opportunistic/ Emergent sampling; Snowball sampling	–Urban health systems actors –National and local government officials –NGO programme managers	16
	Desk review	N/A	N/A	N/A

User Need and	IDIs	Opportunistic/	–Policy makers within	16
User Experience	(on user needs)	Emergent	the MOHFW	
(explore user		sampling;	–Members of the Urban	
preferences, task		Snowball	Health Cell of	
needs and		sampling	MOLGRDC	
experiences)			–Managers at City	
			Corporations	
			–NGO programme	
			managers	
Policy Engagement	KIIs	Opportunistic/	–Urban health systems	15
(understand		emergent	actors	
interactions between		sampling;	–National and local	
content, context,		Snowball	government officials	
actors and processes		sampling	–NGO programme	
of policy advocacy			managers	
and entry points for				
sustainable				
incorporation of ICT	Desk review	N/A	N/A	N/A
into health systems)	(urban health			
	and ICT related			
	policies)			

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3 ICT, Information Communication and Technology; IDI, In-depth Interviews; KII, Key
4 Informant Interviews; MNCH, Maternal, newborn and child health; MOHFW, Ministry of
5 Health and Family Welfare; MOLGRDC, Ministry of Local Government, Rural Development
6 and Cooperatives.
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15 **Implementation procedure of the pilot**

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17 The study implementation is envisaged to begin with stakeholder sensitization and partnership-
18 building with government. This is critical because the research will work closely with the
19 government health system in urban areas. In addition, an intervention will be conducted
20 consisting of capacity building sessions around the use of the UHA for government and other
21 urban health planners and managers. Details of these activities are provided below.
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31 *Stakeholder consultation and engagement:* Two stakeholder consultation workshops will be
32 carried out to identify and engage key stakeholders to create research buy-in and to begin the
33 process of UHA advocacy. Detailed information on identification and mapping of stakeholders
34 has been described in the data collection section. Ideas will be generated for uptake, regular use,
35 and update of UHA.
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45 *Partnership development with Government:* Implementation partnerships with the Management
46 Information System (MIS) of the DGHS, MOHFW will be developed and a Memorandum of
47 Understanding will be signed between icddr,b and DGHS. Permission letters will also be
48 obtained from mayors of CCs and municipalities.
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3 *Development of training materials:* A training manual on Urban Health Atlas (UHA) will be
4 prepared to guide UHA capacity building workshops including case studies, guidelines for group
5 work and hand-on activities, pre-test/post-test questionnaires, etc.
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12 *UHA workshops:* In each study site, a 2-day UHA workshop, and subsequent 1-day refresher
13 course, will be organized with a selected group of health workers and managers drawn from local
14 government, and NGOs. Institutional agreements and permissions will be sought in advance
15 from local government institutions and the health ministry as appropriate. Training sessions will
16 provide an introduction to current urban health challenges, followed by an overview and
17 demonstration of the Urban Health Atlas and its functions. Hands on training, group work and
18 case studies will be undertaken to familiarize users with UHA and to get their feedback on how it
19 might be improved to better meet their needs.
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33 **Data collection**

34 Interviews will be conducted by an experienced group of researchers trained in qualitative
35 interviewing including a mixed method expert, two software programmers, one GIS expert and
36 an economist. The team will begin data collection in Dhaka, then move to the municipalities. A
37 period of rapport building with key stakeholders in each study site will be critical to the success
38 of this research given known difficulties in accessing the Government sector. Utilizing existing
39 networks and negotiation skills will be especially important in opening doors and initiating
40 discussion. The UHA tool will be assessed for impact on MNCH decision-making and outcomes.
41 It is unlikely, however, that these effects would be apparent within three years of
42 implementation. Thus, success of the tool will be determined based on user experiences as
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3 specified by WHO PATH Toolkit i.e. better indicators for strategic planning, day-to-day
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5 decision-making, control and oversight, and reduced administrative burden.
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10 *Data collection methods for objective 1*

11 To address objective 1, assessment of information needs and task review analysis will be done by
12
13 desk review, in-depth interviews and click streams. Guidelines for qualitative interviews will be
14
15 developed based on the WHO PATH toolkit's questions to measure success. Three qualitative
16
17 research activities are envisaged to address this objective:
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- 24 1. Key informant interviews (KIIs) with urban health system actors along with desk reviews
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26 to understand and document how MNCH planning and referral decisions are currently
27
28 made.
29
- 30 2. In-depth interviews (IDIs) with potential UHA users to explore user preferences and task
31
32 needs to refine the tool in advance of training.
33
- 34 3. IDIs with UHA users to understand their experiences and to document challenges and
35
36 successes of using UHA for MNCH service decision-making during training and one- &
37
38 three-months post-training.
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44 In addition to qualitative assessments of user experiences, quantitative assessments of how
45
46 different stakeholders are using data remotely will be made through (i) User's click streams; (ii)
47
48 Task time devoted to different applications. Written feedback through online tools (i.e. Google
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50 Analytics) that facilitate remote testing will also be collected to generate more user-friendly
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52 functions that meet user needs.
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Data collection methods for objective 2

To identify entry points that will facilitate broader use of geo-referenced facility information and its regular update, stakeholder mapping, policy mapping using desk review, KIIs, and stakeholder consultation workshop will be conducted. Guidelines for qualitative interviews will be developed using the policy engagement framework as a guide. Policy and programmatic entry points for the broader use and update of facility information, stakeholder analysis will be undertaken using Policy Engagement Framework as a guide. Stakeholders are identified as persons, groups, organization members or systems that affect or can be affected by a project/program/activity. Stakeholder analysis is an approach for generating knowledge about roles, behavior, inter-relation and intention of associated actors and their influence in implementation processes of a program or policy.[28] Given the importance of stakeholder satisfaction and support for the success of any program,[29,30] incorporating stakeholders' perspectives and needs is a critical step in gaining ownership around an ICT innovation like UHA and its incorporation into routine information systems, and use for decision-making. The following qualitative methods will be used to fulfill objective 2:

1. Stakeholder mapping including the identification and listing of stakeholder groups involved in urban health based on available literature and expert opinion.
2. A semi-structured guideline will be used to collect information during stakeholder consultation workshops to explore their respective interests, roles and responsibilities in urban health, their information needs, and perceptions of how they can contribute to institutionalizing UHA.

3. KIIs along with desk reviews will be undertaken to understand the processes of current health policy-making mechanisms and what other policies affect the integration of ICT in health.

Data collection methods for objective 3

To estimate cost of bringing facility listing into the government information system the total cost of ownership for UHA development and implementation will be estimated using an ingredient approach. Data will be collected through structured questionnaire, document review and KII. Cost will be estimated based on supply side aspects. The budget matrix will be developed with cost drivers proposed in the WHO PATH toolkit.

The cost for development and implementation of Urban Health Atlas (UHA) tools, coordination, and engagement of city corporations and DGHS will be estimated including both financial costs and economic costs of the program. Financial costs represent the actual expenditures on goods and services purchased. Economic costs include the estimated value of goods or services for which either there are no financial transactions or the price of a specific good did not reflect the cost of using it productively elsewhere.[31] The cost will be separated for start-up cost and implementation cost. The implementation cost comprises the costs required to run and maintain the ICT tools while executing intervention.[32]

All supply-side inputs will be identified, quantified, and valued through a facility-level inventory, record reviews and key informant interviews. Both fixed cost and variable cost will be captured. Shared cost items, including salary, buildings, furniture, supervision, transportation, and vehicles, will be identified through observation and interviews of relevant personnel. Shared

costs will be apportioned by proportion of the time-involvement of the relevant items (i.e. office rent, common vehicle) to different activities. The time of volunteers will be transformed into costs by using the minimum wage level of manual workers in Bangladesh. There are some examples of components included in ingredient approaches (table 2):[32,33]

Table 2 Components included in ingredient approaches for cost

Method Name	Methodology	Inputs	Activities
Ingredients approach	Quantities x price, personnel, percentage use	Personnel, ICT tools, vehicles	Personnel, ICT tools, vehicles

ICT, Information Communication and Technology.

To identify activities of the UHA tool implementation and their related inputs, a review of program documents and interviews with relevant personnel will be conducted. The unit price/salary information will be collected from responsible program management. In case of missing unit price of any items, the market price of those items will be collected. Semi-structured checklists for cost data collection will be developed considering the program context and using WHO PATH toolkit as a guiding framework. The budget matrix will be completed with help from key personnel associated with costing and budgeting identified during the stakeholder mapping and research team's own estimates.

Data analysis

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3 A process flowchart for current decision-making practices will be prepared using the KII and
4 Organizational process reviews. A list of user needs will be made and shared at a stakeholder
5 consultation meeting to identify the most important and feasible functions to be added to UHA.
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12 For *qualitative data*, an outline plan for data analysis will be prepared in advance of research
13 along with a priori codes. These codes, mostly focusing on user experience, will be derived from
14 the WHO PATH toolkit.[18] The analysis will be open to emerging themes as well. All
15 interviews will be recorded provided consent has been obtained, but with simultaneous note
16 taking in case of equipment failure. Data transcription will occur immediately following each
17 interview, followed by translation. Data familiarization will involve reading transcripts
18 repeatedly to surface emerging themes and identify any missed opportunities for further
19 exploration. Transcripts will be coded using ATLAS-ti (version-7.5.7). A team approach to
20 analysis will be employed to minimize individual biases. Inter-coder reliability will be checked.
21 Group discussions of emerging themes and patterns in the data will be tested using data displays
22 that allow more systematic pattern-testing across respondents.
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40 For *stakeholder analysis*, stakeholders' influence, importance, and agreement will be explored
41 applying standard techniques and measurement scales mentioned in table 3. A position diagram
42 with level of agreement and level of influence will also be plotted to identify stakeholders who
43 are already committed to work and help institutionalize UHA and those who need to be brought
44 into agreement.
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Table 3 Operational definitions for stakeholder analysis for policy engagement

Theme	Terms used	Operational definition
Influence, importance and agreement analysis of stakeholders	Level of influence	Stakeholders' influence will be determined according to each stakeholder group's perception and views on who is important in terms of urban health care delivery.
	Level of agreement	Stakeholders' agreement will be determined according to how much each stakeholder agreed.
	Level of importance	The stakeholders' importance will be determined according to how important each stakeholder group is to the other groups.
Power and leadership	Overall power	Power of a stakeholder-group will be assessed as compared to all other groups in Bangladeshi urban healthcare delivery system. Power of stakeholders will be measured as the product of multiplication of influence and importance.
	Relative position	Relative position of each stakeholder group will be assessed by comparing one group's position to other groups in broader scenario.
Relative positions of	Drivers	Stakeholders who have high level of importance as well as high level of influence on public sector health care delivery system

stakeholders	Supporters	Stakeholders who have high level of importance but low level of influence on urban healthcare delivery system
	Bystanders	Stakeholders who have low level of importance and low level of influence on urban healthcare delivery system
	Abstainers	Stakeholders who have no influence and no importance on urban healthcare delivery system
	Blockers	Stakeholders who have low level of importance but high level of influence on urban healthcare care delivery system.

For the *policy engagement analysis*, KIIs with stakeholders will be examined to understand interactions between actors, content, context and processes with respect to ICT policy uptake, with a view to identifying entry points for policy advocacy and the sustainable incorporation of ICT in health systems. Interviews will be analyzed using a priori codes drawn from the Policy Engagement Framework. Of additional interest in this analysis is understanding the mechanisms and processes of health policy development and how other policies may be important in efforts to integrate ICT into health systems. Based on these insights, a Health Policy for ICT process flowchart will be prepared. According to the policy engagement framework we will also seek information on how context is considered and dealt with when policies are formed and what processes need to be changed to more effectively integrate UHA into the system.[22]

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5 For *quantitative data*, simple descriptive analysis will be performed to show user rates over time.
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8 The set of parameters to be analyzed are: number of users who accessed UHA, type of user,
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10 scope of UHA use, and types of problems faced. For data analysis, software like MS Excel and
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12 STATA will be used as appropriate.
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17 The *cost* of implementing UHA will be estimated using a direct approach. Average cost for each
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19 activity will be calculated. All supply-side inputs will be identified, quantified, and valued
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21 through record review and KIIs. Shared cost items, including salary, buildings, furniture,
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23 supervision, transportation, and vehicles will be identified through observation and interviews of
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25 relevant personnel. By considering the nature of inputs, these will be categorized into capital,
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27 recurrent as well as fixed and variable cost items. Shared costs will be apportioned by
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29 proportion of the time-involvement of the relevant items (office rent, common vehicle) to
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31 different activities. Inputs will be identified using discussion with relevant personnel,
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33 observation, and record review. If unavailable, market prices will be applied to estimate costs.
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37 The capital items will be annualized, and common costs will be apportioned as per requirement.
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39 Annual values of capital items will be estimated from their expected useful life years and
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41 annuitization will be done using 3% discounting rate whenever applicable.[34] The study will
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43 allocate the cost for shared items (e.g. office space, appliances) by using actual utilization of
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45 items for this activity. Utilization information for shared items will be collected from responsible
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47 project staff.
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51 Finally, the cost for shared items will be estimated by multiplying percentage-use information
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53 with the total cost of the items. Total cost will be calculated by summing up the start-up and
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3 implementation costs. Relative contribution of start-up and implementation cost will be
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5 calculated. The cost-drivers in each activity will be identified considering the larger share of total
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7 cost.
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12 **Process documentation**

14 In addition to all these activities, the study investigators will systematically document
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16 implementation processes for policy uptake and institutionalization of UHA, focusing
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18 particularly on contextual factors and their influence on implementation using a process
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20 documentation template. Process documentation of this “pilot phase” of UHA institutionalization
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22 will generate supporting knowledge to be applied the phases of scale-up and sustain, as specified
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24 in the WHO/PATH toolkit.
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31 **Patient and public involvement**

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33 There will be no direct patient or public involvement in this implementation research. However,
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35 a Technical Advisory Group (TAG) will be formulated for project governance, which will
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37 consist of representatives from Government, development partners, NGOs, academicians and
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39 senior researchers and urban health actors. Regular meetings will be held with partners and staff
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41 for problem solving. At the end of the study, the TAG will comment on the study findings and
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43 contribute to the dissemination plan.
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49 **Ethics and Dissemination**

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51 The institutional review board of icddr,b is comprised of two committees: the Research Review
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53 Committee (RRC) and Ethical Review Committee (ERC). This study has received approval from
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3 both of the committees, which provided a thorough and critical review of the protocol's technical
4 and ethical aspects. Participants will be asked for written consent prior interviewing and will
5 remain anonymous and unidentifiable. Tape recorders will be used to record discussions but only
6 after obtaining consent. All other form of data will be kept in locked storage, or controlled access
7 folders, allowing only investigators of the study and members of the ERC of icddr,b to access
8 information, if needed.
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10
11 Findings from this research will be disseminated at various levels to develop interest and support
12 from a wide variety of audiences i.e. public, private, NGO, civil society, and donors. In doing
13 so, we hope to build a diverse constituency of individuals and organizations willing and able to
14 translate evidence yielded by the study, into policy action.
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31 *Local dissemination:* Findings will be presented to relevant local administrators, development
32 partners and NGOs and other relevant parties (local health practitioners), researchers.
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38 *National dissemination:* A series of interactive workshops and briefing sessions with various
39 stakeholders will be arranged to create linkages with national fora. The main aim will be to
40 translate findings in a more visual and engaging formats, i.e. research briefs and interactive
41 project brochures, to reach a range of stakeholders.
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49 *International dissemination:* This will include publishing findings in peer-reviewed journals and
50 presenting in scientific forums, conferences, and symposiums, and linking with international
51 learning platforms. The main objective is to contribute to global knowledge about context
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3 specific strategies to incorporate ICTs into health systems, and challenges that must be
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5 anticipated for policy uptake necessary to introduce, scale up and sustain MNCH related ICTs in
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7 similar LMICs.
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3 **Figure 1.** Modified conceptual framework for Information Communication and Technology
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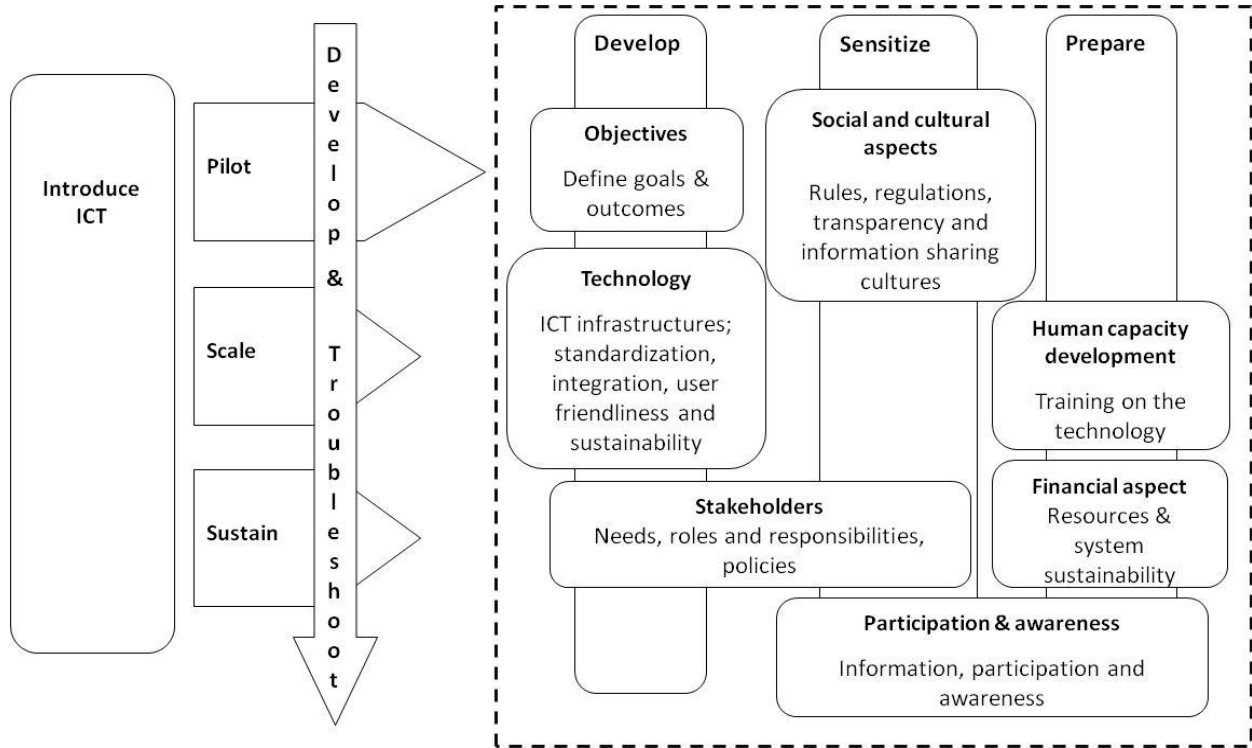


Figure 1. Modified Conceptual framework for Information Communication and Technology (ICT) implementation in developing countries

Reduced MNC morbidity and mortality

Appropriate and timely MNC healthcare

Improved MNCH service coverage

Improved MNCH service quality

Purpose: To improve urban MNCH service planning and monitoring

Input:

1. Health facility data visualization tool

Constraints:

1. Capacity to use and update
2. No ownership within the health system

Activities:

1. Provide training
2. Identify barriers in uptake
3. Costing exercise

Outputs:

1. UHA trained personnel in the MoH, MOLGRDC, CC, NGO
2. List of changes to improve usability
3. Recommendations for policy changes need to facilitate implementation and uptake

Effects:

1. Regular use of UHA for planning decisions by health facility managers and policy makers
2. Better monitoring of health service providers
3. Optimum use of health resources

Context: Heterogenous health systems; poor co-ordination and monitoring; poor quality of healthcare; gaps in urban health service; poor availability and affordability of healthcare for the urban poor

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