Big Data and Reproductive Health in India

A Case Study of the Mother and Child Tracking System

October 2019

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This study was undertaken as part of the **Big Data for Development** network supported by the **International Development Research Centre**, Canada, and is shared under **Creative Commons Attribution 4.0 International** license.

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Glossary

ANMs	Auxiliary Nurse Midwives
ASHA	Accredited Social Health Activist
DBT	Direct Benefit Transfer
DEOs	Data Entry Operators
HIS	Health Information Systems
HMIS	Health Management Information System
ICDS-CAS	Integrated Child Development Services - Common Application Services
ICTs	Information and Communication Technologies
JSY	Janani Suraksha Yojana
MCTS	Mother and Child Tracking System
RCH	Reproductive and Child Health
SDGs	Sustainable Development Goals
SRH	Sexual and Reproductive Health

1. Introduction

Information and Communication Technologies (ICTs) are envisioned as having a threefold role in healthcare: managing health information systems (HIS), communication between beneficiaries and workers, and knowledge sharing.[1] A number of these have been geared towards reproductive health, which is an important indicator of the state of healthcare provision in a country. Innovations in reproductive health informatics have been directed at improving the health of a population rather than an individual,[2] placing great importance in the role of data flows and infrastructure in measuring reproductive healthcare. Such initiatives have been appreciated for aiming to address the historical underrepresentation of the female body in medical research, even if they are aimed at populations over individuals.[3]

The reproductive health information ecosystem in India comprises of a range of different databases across state and national levels. These collect data through a combination of manual and digital tools. Two national-level databases have been launched by the Ministry of Health and Family Welfare - the Health Management Information System (HMIS) in 2008, and the MCTS in 2009.[4] The MCTS focuses on collecting data on maternal and child health. It was instituted due to reported gaps in the HMIS, which records monthly data across health programmes including reproductive health. There are several other state-level initiatives on reproductive health data that have either been subsumed into, or run in parallel with, the MCTS.

[1] Khanna, R., Karikalan, N., Mishra, A., Agarwal, A., Bhattacharya, M. and Das, J. (2013). Repository on maternal child health: Health portal to improve access to information on maternal child health in India. *BMC Public Health*, 13(1).
[2] Dehury, R. (2019). The progress and impact of Health Management Information System (HMIS) in monitoring and evaluation of health programs in India. *Indian Journal of Basic and Applied Medical Research*, 3(4), pp.116-121.
[3] Gold, K., LLP, R., Rudawski, A. and Rose Fulbright, N. (2019). Healthcare Regulatory and Privacy Issues in Reproductive Technologies and Big Data. *American Bar Association*. [online] Available at: https://www.americanbar.org/groups/health_law/publications/aba_health_esource/2018-2019/september2018/regulatory/ [Accessed 11 Nov. 2018].
[4] Press Information Bureau, Government of India (2017). *Healthcare Data*. [online] Available at: http://pib.nic.in/newsite/PrintRelease.aspx?relid=157969 [Accessed 21 Nov. 2018].

With this case study, we aim to evaluate the MCTS as data-driven initiative in reproductive health at the national level. It will also assess its potential to contribute towards the big data landscape on reproductive health in the country, as the Indian state's imagination of health informatics moves towards big data. The methodology for the case study involved a desk-based review of existing literature on the use of health information systems globally, as well as analysis of government reports, journal articles, media coverage, policy documents, and other material on the MCTS.

The first section of this report details the theoretical framing of the case study, drawing on the feminist critique of reproductive data systems. The second section maps the current landscape of reproductive health data produced by the state in India, with a focus on data flows, and barriers to data collection and analysis at the local and national level. The case of abortion data is used to further the argument of flawed data collection systems at the national level. Section three briefly discusses the state's imagination of reproductive health policy and the role of data systems through a discussion on the National Health Policy, 2017 and the National Health Stack, 2018. Finally, we make some policy recommendations and identify directions for future research, taking into account the ongoing shift towards big data globally to democratise reproductive healthcare.

2. Reproductive HIS in the development agenda

In a review by the WHO, it was found that 69 percent of the 62 countries surveyed were monitoring reproductive health indicators through HIS, a majority of which were at least partially digital.[5] These draw on historical efforts within global healthcare to measure and quantify health indicators, including those related to reproductive health. In the context of the global South, the politics of global healthcare funding has led to international donor organisations such as the World Health Organisation, World Bank, and the Gates

[5] ITU, WHO. (2014). *eHealth and innovation in women's and children's health: A baseline review*. [online] Available at: https://www.who.int/goe/publications/baseline_fullreport/en/ [Accessed 23 Oct. 2018].

Foundation driving technological adoption. This has progressed from mHealth and eHealth, to most recently, big data. Big data in healthcare is seen as distinctive because of the precision, speed, and/or range of data points being collected and operationalised to inform healthcare service decisions.[6] In particular, initiatives to meet the Sustainable Development Goals (SDGs), and before those, the Millenium Development Goals (MDGs) have pushed for the creation of new data streams which promote a big data approach.[7]

However, global data initiatives have been critiqued for creating incentives for purpose-specific monitoring systems, as opposed to strengthening existing national health information systems that can be used to meet health data needs in the long-term.[8] HIS initiatives under the MDGs have been critiqued for creating new and multiple data streams within national data systems - mostly structured around disease programmes, which are unable to meet data needs of governments.[9]

The SDGs aim to address this criticism by optimising existing national health information systems rather than generating new data streams.[10] Big data initiatives aiming to achieve the SDGs would then have to build on national HIS, rather than create new data streams to capitalise on existing resources and systems for data management. Such indicators are conceptualised at the level of international organisations and national governments, and negotiated locally. The SDGs take cognizance of this and emphasise a multisectoral approach and disaggregation of data along social variables of inequality, including gender and income.[11] The HIS would need then to be adapted to each national context, including the parameters along which health equity is stratified, such as caste in the Indian context.

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[6] Wyber, R., Vaillancourt, S., Perry, W., Mannava, P., Folaranmi, T. and Celi, L. (2015). Big data in global health: improving health in low- and middle-income countries. *Bulletin of the World Health Organization*, 93(3), pp.203-208.
[7] Galati, A. (2015). Onward to 2030: Sexual and Reproductive Health and Rights in the Context of the Sustainable Development Goals. *Guttsmacher Policy Review*, [online] 18(4). Available at: https://www.guttmacher.org/gpr/2015/10/onward-2030-sexual-and-reproductive-health-and-rights-context-sustainable-development [Accessed 13 Nov. 2018].
[8] Boerma, T., Eozenou, P., Evans, D., Evans, T., Kieny, M. and Wagstaff, A. (2014). Monitoring Progress towards Universal Health Coverage at Country and Global Levels. *PLoS Medicine*, 11(9), p.e1001731.
[9] Nabyonga-Orem, J. (2017). Monitoring Sustainable Development Goal 3: how ready are the health information systems in low-income and middle-income countries?. *BMJ Global Health*, 2(4).
[10] *ibid.*
[11] *ibid.*

The MDGs have also been critiqued for not mentioning sexual and reproductive health (SRH) at all. The SDGs make a significant improvement over this by explicitly referring to SRH and related rights in multiple targets and goals, including 3 (health), 4 (education) and 5 (gender equality). Reproductive health is covered under SDG3, which aims to "Ensure healthy lives and promote well-being for all at all ages". It covers maternal mortality (3.1.1), births attended by skilled health personnel (3.1.2), neonatal and infant mortality (3.2), universal access to sexual and reproductive healthcare services and integration of reproductive health into national strategy (3.7), and satisfaction of family planning needs through modern methods (3.7.1). Access to reproductive health is mentioned separately under SDG5 pertaining to gender equality, as the aim to provide universal access to sexual and reproductive rights (5.6). Nevertheless, Starrs critiques the SDGs for taking a "narrow view of sexual and reproductive health and rights", excluding factors such as non-discrimination on the basis on sexual orientation or gender identity.[12]

As with other reproductive HIS in the global South, the MCTS in India has been implemented as a modality to achieve the targets for the MDGs, and subsequently the SDGs, pertaining to maternal and infant mortality. It is a purpose-specific HIS, aimed at reducing redundancies and duplication in manual forms of data collection.

3. Mother and Child Tracking System: Objectives, challenges, and solutions

3.1. Functions and aims of the MCTS

The MCTS is a national HIS aimed at tracking maternal and child beneficiaries of the public health system in India. The system was implemented as the Pregnancy, Child Tracking, and

[12] Starrs, A. (2015). 'Comment: A Lancet Commission on sexual and reproductive health and rights: going beyond the Sustainable Development Goals'. *The Lancet,* Vol. 386

Health Services Management System in Rajasthan in 2009[13] before being launched in the rest of the country in 2011. It was originally launched as a flagship "mission mode project" as part of an overall plan to enhance the "efficiency, transparency, and reliability"[14] of the state of Rajasthan through e-governance, under the National e-Governance Plan.[15] It was implemented in collaboration with the National Rural Health Mission, and the National Informatics Centre, with the latter creating and maintaining the data infrastructure of the MCTS. As of 2018, 12 crore pregnant women and 11 crore children have been registered on the portal.[16] 67.57 percent of estimated pregnant women in the country have been registered on the platform as of 2015-16.[17]

In most states, data collection is done manually by Auxiliary Nurse Midwives (ANMs) or Multi Purpose Health Workers in pre-formatted MCH registers at sub-centres. This data is then digitised at the closest Primary or Community Health Centre into the MCTS portal by Data Entry Operators (DEOs), who also generate physical copies of monthly 'MCTS' work plans for ANMs, containing upcoming services to be delivered along with a list of beneficiaries. Work plans can either be taken physically by ANMs upon their visit to the Primary or Community Health Centre, or in the case of simple work plans, can be sent through SMS.[18] These Centres then report this data to district offices, which collect district-level data to be sent to the state government, and states to the central government. The system has role-based access and authentication, which restricts the ability to

[13] Press Information Bureau, Government of India. (2013). *Mother and Child Tracking System*. [online] Available at: http://pib.nic.in/newsite/PrintRelease.aspx?relid=101311 [Accessed 13 Nov. 2018].
[14] Digital India. (n.d.). *EKRANTI - ELECTRONIC DELIVERY OF SERVICES*. [online] Available at: https://digitalindia.gov.in/content/ekranti-electronic-delivery-services [Accessed 19 Nov. 2018].
[15] Ministry of Health and Family Welfare, Government of India (2011). *Order regarding constitution of State and District Project e-Mission Teams*. New Delhi. Available at: http://nrhm-mcts.nic.in/MCH/Documents/e_Mission.pdf [Accessed 7 Dec. 2018].
[16] mohfw.gov.in. (2019). *e-Health & Telemedicine*. [online] Available at: https://mohfw.gov.in/about-us/departments/departments-health-and-family-welfare/e-Health%20%26%20Telemedicine [Accessed 7 Dec. 2018].
[17] Press Information Bureau Government of India Ministry of Health and Family Welfare (2015). *Ministry of Health and Family Welfare Notable Achievements and Initiatives- 2015*. [online] Available at: http://pib.nic.in/newsite/PrintRelease.aspx?relid=133853 [Accessed 14 Nov. 2018].
[18] Study of Public Health IT Systems in India Background Study for ICT subgroup of Sector Innovation Council in Health. (2019). [online] New Delhi: National Health Systems Resource Centre and Taurus Glocal Consulting. Available at: http://nhsrcindia.org/sites/default/files/Public%20Health%20IT%20Systems%20Study%20NHSRC_0.pdf [Accessed 17 Nov. 2018].

undertake analysis to supervisors and DEOs.[19] Beneficiaries have access to a tabulation of completed and pending health services on the MCTS portal.[20]

The MCTS collects the following data:

- personal details of all pregnant women,
- antenatal check-up chart for registered pregnant women,
- data of all visits from conception up to 42 days post-partum,
- immunisation schedules of all children up to 5 years of age,
- family planning and counselling requirements for sterilisation,
- demographic details and contact numbers of all health workers in each facility, and
- details of all welfare schemes being availed by the beneficiaries.

The records of each mother and child are tracked through a Maternal Health Card, which contains a 16-digit unique identification number, containing the codes on the state, district, block, health centre, woman and/or child code and serial number. The central government has been in the process of linking the MCTS with the Aadhaar since 2015, however it is unclear whether it has fully been linked.[21] The linkage is aimed at authenticating beneficiaries and health workers at the point of service delivery and availing benefits.

The objective of the MCTS is to ensure that "all pregnant women receive their full antenatal care and postnatal care services at the due times" (implying 42 days post-partum); increased institutional deliveries for pregnant women, particularly for high risk mothers; and immunisation of all children between 0 to 5 years of age. This is aimed at reducing maternal and child mortality and morbidity indicators and overall improvement in reproductive health outcomes.[22] It is further envisioned as a monitoring and evaluation mechanism of

[19] Bhati, D. (2015). Impact of Technology on Primary Healthcare Information Management: A Case of North India. *The American Health Information Management Association*.
[20] Press Information Bureau, Government of India (2012). *India is the Second-Largest Mobile Phone user in World*. [online] Available at: http://pib.nic.in/newsite/PrintRelease.aspx?relid=85669 [Accessed 16 Nov. 2018].
[21] Press Information Bureau, Government Of India (2019). *Caring for the mother and child: Health Ministry makes innovative use of technology to provide ante-natal and post-natal care*. [online] Available at: http://pib.nic.in/newsite/mbErel.aspx?relid=114861 [Accessed 20 Nov. 2018].
[22] *ibid.*

welfare projects on reproductive health, and collect data on challenges to delivery from national to local levels, expected to lead to more efficient programme management.[23]

The reproductive and child health (RCH) programme in India has taken a "beneficiary-centered approach" to service provision following the International Conference on Population and Development in 1994 - at least at the level of policymaking.[24] Accordingly, a core function of the MCTS is purportedly democratising reproductive healthcare provisioning - or to "reposition the mobile phone from a mere communication device to an instrument of empowerment and...take health care services to the doorstep of ordinary people."[25] This is partly implemented through the mHealth component to MCTS, through which beneficiaries and health workers receive updates through SMS on their mobile phones. The SMS update is used to communicate health information to beneficiaries, as well as reminders for upcoming occasions of service delivery to beneficiaries and health workers. There is also a Mother and Child Tracking Facilitation Centre, which is a call centre that verifies MCTS records, besides collecting feedback on the provision of services. As of June 2018, 1.2 crore beneficiaries have been contacted through this system.[26] This is in addition to an MCTS Cell at the national level which monitors and analyses data and identifies gaps, including districts or facilities that aren't reporting.[27]

The MCTS is also a key component of the infrastructure that facilitates Direct Benefit Transfers (DBTs) for the Janani Suraksha Yojana (JSY), which is a scheme to promote institutional delivery through cash assistance for deliveries and post-natal care for the mother. Launched in 2005, data on the JSY has been integrated into the MCTS since the

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[23] Press Information Bureau, Government Of India (2012). *Services on Track: Over Two Crore Women Beneficiaries Registered with MCTS*. [online] Available at: http://pib.nic.in/newsite/mbErel.aspx?relid=83636 [Accessed 16 Nov. 2018].
[24] Simon Kumar, R. (2004). *Marketing Reproduction?: Political Rhetoric and Gender Policy in India*. New Delhi: Zubaan.
[25] Press Information Bureau, Government of India (2012). *India is the Second-Largest Mobile Phone user in World*. [online] Available at: http://pib.nic.in/newsite/PrintRelease.aspx?relid=85669 [Accessed 16 Nov. 2018].
[26] Integrated Child Development Services, Ministry of Women and Child Development, Government of India, (2018). *RCH Portal & Allied Initiatives of MoHFW*. Available at: https://www.icds-wcd.nic.in/nnm/Events/TechThon/ExistingTechnologyPlatform_for_HealthSchemes_MoHFW-28-06-2018.pdf [Accessed December 7. 2018]
[27] Press Information Bureau, Government Of India (2012). *Services on Track: Over Two Crore Women Beneficiaries Registered with MCTS*. [online] Available at: http://pib.nic.in/newsite/mbErel.aspx?relid=83636 [Accessed 16 Nov. 2018].

inception of the latter. DBTs were enabled by synchronising the JSY with the Central Plan Schemes Monitoring System, and then linking the MCTS identification number with the Aadhaar infrastructure.

3.2. Challenges with the MCTS

3.2.1. Failure in data entry and digitisation

Several critiques have been made of the MCTS by researchers and health workers,[28] some of which can be broadly applicable across the reproductive HIS infrastructure in India. It has been found that the data fed into the portal is significantly incomplete, with a high proportion of fields being left empty at the point of first entry. Causes behind the failure of entry could include lack of clarity among health workers regarding the variable to be entered. For instance, Bhattacharya et al. found different interpretations of a variable regarding the number of women who had received antenatal care in their first trimester versus the first three months of the year, primarily as a result of unclear translations of the English text into Hindi.[29]

Inadequate training has also manifested in the inability to understand technical medical terminology in English in the kind of language used portal by health workers, including terms such as 'hypothermia' and 'eclampsia,'[30] leading to frequent misinterpretation. The format itself has thus been found "complex and difficult to comprehend" by health workers who are often educated only till high school.[31] Further, only DEOs are provided any training

[28] See for instance L. N., D. and D., G. (2016). Evaluation of health information system in reproductive and child health program at primary health center level: a system analysis. *International Journal Of Community Medicine And Public Health*, 4(1), p.15.
[29] Bhattacharya, M., Shahrawat, R. and Joon, V. (2012). Understanding Level of Maternal and Child Health Indicators used in Health Management Information System among Peripheral Level Health Functionaries in Two Districts of India. *Journal of Health Informatics in Developing Countries*, 6(1).
[30] Bhattacharya, M., Shahrawat, R. and Joon, V. (2012). Understanding Level of Maternal and Child Health Indicators used in Health Management Information System among Peripheral Level Health Functionaries in Two Districts of India. *Journal of Health Informatics in Developing Countries*, 6(1).
[31] Bhattacharya, M., Shahrawat, R. and Joon, V. (2012). Understanding Level of Maternal and Child Health Indicators used in Health Management Information System among Peripheral Level Health Functionaries in Two Districts of India. *Journal of Health Informatics in Developing Countries*, 6(1).

at all, while health workers are expected to work solely on physical registers.[32] This is hugely contrary to findings from research in other parts of the global South, which have indicated the need for health workers and community members to be engaged in the design of the system before its implementation for it to be sustainable.[33]

Another complexity is the existence of variables that do not fit into the social context of the community. For instance, in a study in North India, it was found that only 80 percent of pregnant women provided any mobile numbers, of which two thirds gave numbers operated by their husbands.[34] Of the ones that provided their own numbers, 22 percent received an SMS, and only a third of whom could actually understand its content.[35] Digitally driven initiatives such as the MCTS have thus failed to address the gendered digital gap[36] in their implementation, even when women are the primary target group.

There are other indicators of the inflexibility of the MCTS. The options for data entry and outputs are preconfigured and inflexible, which makes it difficult to adapt the system to local requirements. Creating other work plans in addition to predetermined formats is also not possible within its current infrastructure.

Lack of standardisation across different data tools and processes has also been a point of criticism across the MCH physical register and digital portal, and between the HMIS and MCTS portals.[37] It has been found that some variables are named differently in the MCH register and the portal, leading to failure in data digitisation after collection.[38] Lack of

[32] Bhattacharya, M., Shahrawat, R. and Joon, V. (2012). Understanding Level of Maternal and Child Health Indicators used in Health Management Information System among Peripheral Level Health Functionaries in Two Districts of India. *Journal of Health Informatics in Developing Countries*, 6(1).
[33] ITU, WHO. (2014). *eHealth and innovation in women's and children's health: A baseline review*. [online] Available at: https://www.who.int/goe/publications/baseline_fullreport/en/ [Accessed 23 Oct. 2018].
[34] Nagarajan, P., Tripathy, J., Goel, S. (2016). Is mother and child tracking system (MCTS) on the right track? An experience from a northern state of India. *Indian Journal of Public Health*, 60(1), p.34.
[35] Nagarajan, P., Tripathy, J., Goel, S. (2016). Is mother and child tracking system (MCTS) on the right track? An experience from a northern state of India. *Indian Journal of Public Health*, 60(1), p.34.
[36] Kuroda, R. (2019). 'Policy brief. The digital gender gap'. *W-20 Japan 2019*. Available at: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2019/02/Digital-Equity-Policy-Brief-W20-Japan.pdf
[37] Gera, R., Muthusamy, N., Bahulekar, A., Sharma, A., Singh, P., Sekhar, A. and Singh, V. (2015). An in-depth assessment of India's Mother and Child Tracking System (MCTS) in Rajasthan and Uttar Pradesh. *BMC Health Services Research*, 15(1).
[38] *ibid*.

interoperability standards and sharing of data across public health programmes and other governmental departments arise due to systems that are largely designed to serve a few definitive purposes and function in "data silos."[39] Another gap in the data collected by the MCTS is the sole focus on public data, with no mechanisms to capture or integrate reproductive health data from private medical institutions and practitioners.[40]

3.2.2. Resource poverty and inflexible systems

A separate challenge across reproductive HIS is inadequacy of infrastructure, as primary and community health centres lack hardware, stable connectivity, and regular electricity.[41] There is also an absence of adequate human resources across the public health system in the country. A qualitative study done in the states of Uttar Pradesh and Rajasthan indicates severe human resource deficiencies with a lack of dedicated DEOs, and excessive work burden on the DEOs present (one DEO serves a population of about 2 lakh in these states).[42] ANMs spend an average of 6 hours a week for data collection in addition to their routine activities on the MCTS.[43] The time calculated also includes time spent traveling to and from sub-centres to primary health centres weekly.[44] This then takes time away from performing implementation activities, including patient care and follow up. Overwhelming workloads have also resulted in time lags between data collection and digitisation. In a study on

[39] Study of Public Health IT Systems in India Background Study for ICT subgroup of Sector Innovation Council in Health. (2019). [online] New Delhi: National Health Systems Resource Centre and Taurus Glocal Consulting. Available at: http://nhsrcindia.org/sites/default/files/Public%20Health%20IT%20Systems%20Study%20NHSRC_0.pdf [Accessed 17 Nov. 2018].
[40] Additionally, more than half of India's health workers work in the unorganised private sector, with no system of registration. More information available at: Central Bureau of Health Intelligence Directorate General of Health Services Ministry of Health & Family Welfare, Government of India (2018). *National Health Profile 2018*. New Delhi. [online] Available at: http://www.indiaenvironmentportal.org.in/files/file/NHP%202018.pdf [Accessed 17 Nov. 2018].
[41] Gera, R., Muthusamy, N., Bahulekar, A., Sharma, A., Singh, P., Sekhar, A. and Singh, V. (2015). An in-depth assessment of India's Mother and Child Tracking System (MCTS) in Rajasthan and Uttar Pradesh. *BMC Health Services Research*, 15(1).
[42] Karvande, S., Sonawane, D., Chavan, S. and Mistry, N. (2016). What does quality of care mean for maternal health providers from two vulnerable states of India? Case study of Bihar and Jharkhand. *Journal of Health, Population and Nutrition*, 35(1).
[43] Nagarajan, P., Tripathy, J., Goel, S. (2016). Is mother and child tracking system (MCTS) on the right track? An experience from a northern state of India. *Indian Journal of Public Health*, 60(1), p.34.
[44] Nagarajan, P., Tripathy, J., Goel, S. (2016). Is mother and child tracking system (MCTS) on the right track? An experience from a northern state of India. *Indian Journal of Public Health*, 60(1), p.34.

Saharsa District of Bihar, it was found that the average time lag between primary data entry on paper and digitisation of that data was 72 days, with only 0.04 percent data being entered into the MCTS portal on the same day.[45]

In addition, DEOs and health workers work on entering data into multiple databases at the same time, which include the HMIS and ICDS-CAS in addition to the MCTS, not to include several other purpose-specific management systems. Approximately half of this data is overlapping but recorded separately in each.[46] Wyber et al. critique several big data initiatives across low-income settings for diverting scarce resources away from critical activities to non-essential collection of data.[47]

The existence of multiple databases in resource poor settings has implied that wide discrepancies have been noticed between core variables such as number of pregnant women and children registered, and rate of service delivery, in the HMIS and MCTS.[48] It should be noted that these issues regarding multiplicity of databases and paucity of human resources were meant to be addressed by a digitised system.[49] Instead, these public HIS have been modeled along pre-existing manual systems, resulting in a focus on data entry and inadequate focus on analytical processing.[50]

In fact, as Nagarajan et al. find, the MCTS software only has analytical capability to check for validation of data entry.[51] In other words, data processing at the local level is restricted

[45] Balakrishnan, R., Gopichandran, V., Chaturvedi, S., Chatterjee, R., Mahapatra, T. and Chaudhuri, I. (2016). Continuum of Care Services for Maternal and Child Health using mobile technology – a health system strengthening strategy in low and middle income countries. *BMC Medical Informatics and Decision Making*, 16(1).
[46] Kapilashrami M.C. and Tiwari V.K., 'Review study on National Health Information System in two states of India', available at http://www.hihfw.org/material/research/r190.doc
[47] Wyber, R., Vaillancourt, S., Perry, W., Mannava, P., Folaranmi, T. and Celi, L. (2015). Big data in global health: improving health in low- and middle-income countries. *Bulletin of the World Health Organization*, 93(3), pp.203-208.
[48] Gera, R., Muthusamy, N., Bahulekar, A., Sharma, A., Singh, P., Sekhar, A. and Singh, V. (2015). An in-depth assessment of India's Mother and Child Tracking System (MCTS) in Rajasthan and Uttar Pradesh. *BMC Health Services Research*, 15(1).
[49] Bhati, D. (2015). Impact of Technology on Primary Healthcare Information Management: A Case of North India. *The American Health Information Management Association*.
[50] Gera, R., Muthusamy, N., Bahulekar, A., Sharma, A., Singh, P., Sekhar, A. and Singh, V. (2015). An in-depth assessment of India's Mother and Child Tracking System (MCTS) in Rajasthan and Uttar Pradesh. *BMC Health Services Research*, 15(1).
[51] Nagarajan, P., Tripathy, J., Goel, S. (2016). Is mother and child tracking system (MCTS) on the right track? An experience from a northern state of India. *Indian Journal of Public Health*, 60(1), p.34.

to check for completeness. It is unclear through current literature if, and at what point, data is then processed for generating health indicators and programme management interventions at the local levels. An inordinate focus on data entry has resulted in persistent absence of feedback from higher authorities to health workers.[52] Digital reproductive health HIS could then accentuate some of the concerns regarding processes in manual systems, by creating systems with data flows from the bottom to top without processing power distributed adequately across the hierarchy.

These constraints around "poor training, perception of health information systems as increasing workload in resource poor settings, and lack of user-friendly systems" have also been found in other contexts in the global South, such as Tanzania and Mozambique.[53] Thiagrajan et al. describe the process of adoption of the MCTS and other HIS in India as beginning with "high expectations, followed by achievement of modest functionality... overload, and finally a collapse followed by the next cycle of development."[54]

3.3. MCTS 2.0: The RCH portal

The next cycle of development for the MCTS is the Reproductive and Child Health (RCH) portal, which has been replacing it in a phased manner from 2015 onwards.[55] The RCH portal aims to track eligible couples for their contraceptive needs, pregnant women, and children.[56] This is an improvement over the MCTS, which restricts data gathering to antenatal and postnatal periods and deliveries. Time lags in data entry in the MCTS have

[52] Nagarajan, P., Tripathy, J., Goel, S. (2016). Is mother and child tracking system (MCTS) on the right track? An experience from a northern state of India. *Indian Journal of Public Health*, 60(1), p.34.
[53] Kimaro H.C., Nhampossa J.S. (2005) Analyzing the problem of unsustainable health information systems in less-developed economies: case studies from Tanzania and Mozambique. *Information Technology for Development* 11, pp. 273-298.
[54] Thiagarajan, S., Gupta, P., Mishra, A., Vasisht, I., Kauser, A. and Mairembam, D. (2012). Designing an information technology system in public health: observations from India. BMC Proceedings, 6(S5).
[55] Ministry of Health and Family Welfare, Government of India (2015). *RCH Portal Data Entry User Manual V1.1, Data Entry Section User Manual*. Available at: http://www.nhmmp.gov.in/WebContent/IMP_Notice/Draft_Revised_Data_Entry_User_Manual_ver_1_1-RCH.pdf [Accessed January 20. 2019]
[56] Integrated Child Development Services, Ministry of Women and Child Development, Government of India, (2018). *RCH Portal & Allied Initiatives of MoHFW*. Available at: https://www.icds-wcd.nic.in/nnm/Events/TechThon/ExistingTechnologyPlatform_for_HealthSchemes_MoHFW-28-06-2018.pdf [Accessed December 7. 2018]

been addressed in the RCH through the introduction of a software called Auxiliary Nurse Midwife Online (ANMOL), which is slowly being rolled out.[57] Designed in collaboration with UNICEF, ANMOL enables data collection at the source, as data is entered through tablets provided directly to frontline health workers. This also reduces the burden of manual data entry and travel for ANMs.

The RCH portal has an integrated dashboard with weekly or daily work plans, a list of due services, and alerts for services to be provided to high-risk patients. Information on government programmes and schemes is also available on the portal. The portal functions without internet connectivity, uploading the data to the central server once the device is connected.[58] This overcomes a major flaw pointed out in the MCTS, which does not allow for offline data entry. In another upgrade over the MCTS, the RCH provides multilingual support. It is also set to be made interoperable with the ICDS-CAS, an HIS tracking nutrition among children, operated by the Ministry for Women and Child Development.[59] The two databases are being made interoperable by providing a template for the integration of the ICDS-CAS with the MCTS/RCH, which will facilitate "auto-population" of information across both.[60]

Other concerns around the lack of infrastructure, training, and a range of flaws in the system design and implementation of the HIS continue to persist in the RCH. Inadequate training for health workers could imply lack of engagement with tablets, as workers continue to perceive data collection as an additional burden rather than reducing or streamlining workload. The RCH system also ignores issues of flexibility and local usage, posing similar challenges of focus on data entry without enough usage. Concerns around data protection and privacy get amplified even further, as the RCH portal eventually aims to

[57] Press Information Bureau, Ministry of Health and Family Welfare. (2016). *On World Health Day, Health Minister launches new health initiatives and Mobile APPS*. [online] Available at: http://pib.nic.in/newsite/PrintRelease.aspx?relid=138674 [Accessed 16 Nov. 2018].
[58] Integrated Child Development Services, Ministry of Women and Child Development, Government of India, (2018). *RCH Portal & Allied Initiatives of MoHFW*. Available at: https://www.icds-wcd.nic.in/nnm/Events/TechThon/ExistingTechnologyPlatform_for_HealthSchemes_MoHFW-28-06-2018.pdf [Accessed December 7. 2018]
[59] *ibid.*
[60] Press Information Bureau, Ministry of Women and Child Development. (2017). *Multi-pronged strategy adopted by government to tackle malnutrition in the country*. [online] Available at: http://pib.nic.in/PressReleaseIframePage.aspx?PRID=1514493 [Accessed 26 Nov. 2018].

collect information in real-time across the country. This is particularly relevant in the absence of a data protection law, as the RCH collects extremely sensitive health information about contraceptive and reproductive needs. Other design-specific concerns, such as the continuation of the target-based approach with the MCTS/RCH will be discussed below.

3.4. Conflicting interests: Local usage versus managerial control

Health workers expressed the pressure of the 'managerial gaze' of their supervisors that the MCTS/RCH contributes towards. One of the broad functions of the MCTS/RCH is the perception of managerial oversight in the absence of proper feedback mechanisms. As a result of the managerial gaze upon data collection and meeting targets rather than improving programme implementation, health workers may be incentivised to enter inaccurate data for the fear of reprisal. This is especially the case in underperforming areas that are unable to meet targets set by government officials.[61] This is then also reflective of the problems inherent with the target-based approach to reproductive welfare and population control, which has historically been taken in India.[62] Although officially discarded in favour of a rights-based approach, targets for a number of indicators including fertility rates and family planning continue to be set. The primary function of the data collected then becomes to assess services delivered against set targets.

Hierarchies in data flows and analytical power can be seen as a consequence of a "health system with rigid internal hierarchies and power differentials", foreclosing a focus on learnability in favour of its function as a monitoring tool.[63] This can be linked to the status

[61] Balakrishnan, R., Gopichandran, V., Chaturvedi, S., Chatterjee, R., Mahapatra, T. and Chaudhuri, I. (2016). Continuum of Care Services for Maternal and Child Health using mobile technology – a health system strengthening strategy in low and middle income countries. *BMC Medical Informatics and Decision Making*, 16(1).
[62] Rathi, A. and Tandon, A. (2019). Data Infrastructures and Inequities: Why Does Reproductive Health Surveillance in India Need Our Urgent Attention?. *Economic and Political Weekly Engage,* 54 (6). [online] Available at: https://www.epw.in/engage/article/data-infrastructures-inequities-why-does-reproductive-health-surveillance-india-need-urgent-attention
[63] Simon Kumar, R. (2004). *Marketing Reproduction?: Political Rhetoric and Gender Policy in India.* New Delhi: Zubaan.

of local health workers in the Indian healthcare system. Accredited Social Health Activists (ASHAs) who have been labelled the "backbone" of India's rural and urban systems "for low-income and the most poor and deprived communities", are not even recognised as government employees and are treated instead as voluntary workers without salary or benefits.[64]

The managerial gaze could then come into conflict with the other objectives of the MCTS/RCH, which is to plug data gaps in implementation at the ground level at each sub-centre. This also results from the narrow framework of assessing reproductive health programmes through specific indicators that are determined through international and national bodies, without any focus on local needs.

4. Measuring reproductive health

Datafication assumes perfect alignment between the objectives of the state, data systems, and the bodies of citizens. Heavy investment in the digitisation of health data assumes a constant, apolitical notion of data. It says nothing of the fact that data is always situated and contingent, and that the very notion of 'raw data' has been construed to be an oxymoron.[65] Notions of 'objective' quantification have been debunked by feminist critiques of classical epistemology. Feminists have critiqued the treatment of gender and other social categories as stable rather than socially constructed roles that function within relations and structures of power.[66] In such a treatment, women are assumed to be autonomous subjects making demands upon, and bargains with the state rather than negotiating through relationships with power differentials. Framing RCH as a data scarcity problem could then engender an approach which might blame women for their inability to access services, at the cost of ignoring structural issues.[67]

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[64] Krishnan, K. (2019). Indefinite strike by Bihar's ASHA workers is another reminder that they are overworked, underpaid. *Scroll.in*. [online] Available at: https://scroll.in/pulse/906384/indefinite-strike-by-bihars-asha-workers-is-another-reminder-that-they-are-overworked-underpaid [Accessed 28 Dec. 2018].
[65] Gitelman, L. (2004). *"Raw Data" Is an Oxymoron*. London: The MIT Press.
[66] Haraway, D. (1988). Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies,* 14 (3), pp. 575-599.
[67] Gaitonde, R. (2012). Registration and monitoring of pregnant women in Tamil Nadu, India: a critique. *Reproductive Health Matters*, 20(39), pp.118-124.

Health information management functions under the assumption that a critical factor in inadequate and poor quality healthcare provision is the scarcity of data on each patient and service delivery.[68] There is then a tendency to make direct causal links between data collection, data analysis, and eventually better decision-making and programme implementation. This has proven to not be the case, especially in resource poor settings.[69] This also affects the analytical capacity of reproductive HIS to disaggregate data along social axes such as gender and education, which is a key focus of the SDGs.[70]

Nevertheless, policy documents and reportage around the MCTS has framed it as a panacea to solving the entire range of aspects of reproductive health, from breastfeeding,[71] anaemia and malnutrition,[72] to maternal and neonatal tetanus.[73] Data-driven policymaking then risks excluding other causes of maternal and child mortality or morbidity, such as social or mental ones.[74] This is despite socioeconomic factors having a strong correlation with availability and access to healthcare services for women, including age at marriage, income and education levels, geographical location, religion, among others.[75]

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[68] Rathi, A. and Tandon, A. (2019). Data Infrastructures and Inequities: Why Does Reproductive Health Surveillance in India Need Our Urgent Attention?. *Economic and Political Weekly Engage*, 54 (6). [online] Available at: https://www.epw.in/engage/article/data-infrastructures-inequities-why-does-reproductive-health-surveillance-india-need-urgent-attention

[69] Bhattacharya, M., Shahrawat, R. and Joon, V. (2012). Understanding Level of Maternal and Child Health Indicators used in Health Management Information System among Peripheral Level Health Functionaries in Two Districts of India. *Journal of Health Informatics in Developing Countries*, 6(1).

[70] Nabyonga-Orem, J. (2017). Monitoring Sustainable Development Goal 3: how ready are the health information systems in low-income and middle-income countries?. *BMJ Global Health*, 2(4).

[71] Press Information Bureau, Government of India. (2017). *Why do we need to promote breastfeeding?*. [online] Available at: http://pib.nic.in/newsite/printrelease.aspx?relid=169387 [Accessed 21 Nov. 2018].

[72] Press Information Bureau Government of India (2017). *Breaking Inter-generational Cycle of Malnutrition & Optimising the IYCF Practices*. [online] Available at: http://pib.nic.in/newsite/printrelease.aspx?relid=170335 [Accessed 13 Nov. 2018].

[73] Press Information Bureau, Government of India. (2015). *Call to Action Summit-2015 Happy to share that Maternal and Neonatal Tetanus has been eliminated from India: PM Sustainable inter-sectoral efforts needed to move forward to achieve bolder goals: Union Health Minister*. [online] Available at: http://pib.nic.in/newsite/PrintRelease.aspx?relid=126377 [Accessed 13 Nov. 2018].

[74] Graham, W. and Campbell, O. (1992). Maternal health and the measurement trap. *Social Science & Medicine*, 35(8), pp.967-977.

[75] World Health Organisation (2010). *Social determinants of sexual and reproductive health: Informing future research and programme implementation*. [online] Available at: https://www.who.int/reproductivehealth/publications/social_science/9789241599528/en/ [Accessed 20 Oct. 2018].

Thomas et al. find that a number of reproductive ailments are underreported by women, such as Urinary Tract Infections and Sexually Transmitted Infections, which are also excluded from the scope of the MCTS and HMIS.[76] ICT projects are characterised as avoiding the "contentious" aspects of reproductive health, such as gender-based violence.[77] This can be seen as a consequence of the MCTS and other reproductive health HIS taking a very narrow view of reproductive wellbeing - framing it within the time period from conception to delivery rather than a lifelong state. Thus all aspects related to the reproductive health of a female apart from the period of motherhood are excluded from their purview. This also aligns with the construction of gender and femininity within the RCH programme historically, which uses the terms 'mother' and 'woman' interchangeably.[78] The MCTS, and in fact the reproductive and child health programme, treat reproductive health as maternal health, and in the process, rest the entire burden of family planning on the woman.[79]

Further, the MCTS and RCH only collect quantitative data which is easier to record, standardise, and communicate through indicators. Attempts at quantification of reproductive health have been spearheaded by international organisations, with different countries adopting different indicators on the basis of national priorities. The Indian state, for instance, has been historically tracking family planning outcomes through reproductive health indices in line with the historical emphasis on population control and family planning within the RCH programme.[80] Women then become instruments of meeting state agendas, which in the Indian case are development goals regarding population control and poverty reduction.

Such a framework is unable to capture data on services that are crucial to reproductive healthcare provision but do not reflect in managerial agendas, such as engagement with the

[76] Thomas, M., Narayan, P. and Christian, C. (2012). Mitigating gaps in reproductive health reporting in outlier communities of Kerala, India—A mobile phone-based health information system. *Health Policy and Technology*, 1(2), pp.69-76.
[77] Waldman, L. and Stevens, M. (2015). Sexual and reproductive health and rights and mHealth in policy and practice in South Africa. *Reproductive Health Matters*, 23(45), pp.93-102.
[78] Simon Kumar, R. (2004). *Marketing Reproduction?: Political Rhetoric and Gender Policy in India*. New Delhi: Zubaan.
[79] *ibid.*
[80] Ramanathan, M. (1998). Reproductive Health Index: Measuring Reproduction or Reproductive Health. *Economic and Political Weekly*, 33(49).

community. By excluding such context-specific services from the purview of the monitoring system, the state incentivises the agenda for reproductive health formulated by international and national bodies over that of health workers.

In fact, the inception of a digitised HIS in the 1990s was primarily to improve the cost-effectiveness of reproductive healthcare delivery.[81] Measurement initiatives at global scales have then been critiqued as top-down "micro-practices of neoliberalism".[82] The defining function of measurement then becomes to produce narratives to support future investment in reproductive health, and effectiveness of donor programmes.[83] The politics of determining reproductive health indicators at a global scale has also been well documented, driven by the need to ensure political priority for reproductive health, and justify donor investment in the area.[84] Thus although widely critiqued by activists in the global South, institutionalised deliveries have remained on the agenda of global measurement including the SDGs.[85] This is to the detriment of traditional midwives, who are excluded from the scope of 'skilled practitioners', increasing incidences of cesarean births, and lack of quality care at government institutions.

Reproductive health indicators are determined in the global North, pushing the agenda of global agencies than local implementation, raising concerns regarding whose data needs are being met, and who is being held accountable to whom through data flows.[86] Indicators are thus value-laden and quantified through indirect modelling techniques, due to the poor quality of data and pressure to meet political goals.

[81] Singh, A., Moidu, K., Trell, E. and Wigertz, O. (1992). Impact on the management and delivery of primary health care by a computer-based information system. *Computer Methods and Programs in Biomedicine*, 37(1), pp.55-64.
[82] Adams, V. (2016). Metrics of the global sovereign: Numbers and stories in global health. In V. Adams (Ed.), *Metrics: What counts in global health* (pp. 21–68). Durham, NC: Duke University Press.
[83] Storeng, K. and Béhague, D. (2016). "Guilty until proven innocent": the contested use of maternal mortality indicators in global health. *Critical Public Health*, 27(2), pp.163-176.
[84] *ibid.*
[85] *ibid.*
[86] *ibid.*

5. Concluding remarks

The digitisation of the MCTS was meant to address the burden of manual data collection and duplicity, which continue to persist within digital infrastructures. The issues that digitisation was originally aimed at solving, including democratisation of reproductive healthcare, better provisioning, and reduced burden on health workers, were left unaddressed even as additional functions continue to be built on top of existing data processes. Concerns around the lack of infrastructure, human resources, training, and a host of other flaws in data collection and analysis continue to persist in the MCTS/RCH that will now be geared towards enabling future data-driven initiatives.

There are multiple objectives that the MCTS/RCH is aimed at, including management of reproductive healthcare service delivery, and planning and utilisation of data locally. As has been noted above, these two objectives can come into conflict, where the system is too complex for workers, or data inaccuracies could be incentivised as a result of the target-based approach. Some of these concerns can be mitigated through RCH, which has greater potential to design a system towards local utilisation of data. **Needs of workers in each context need to be identified and addressed in the design of the system, demanding a fundamental shift in the aims of digitised information systems.**

The RCH would then need to enable meaningful analysis and usage of data at the level of sub-centres and primary and community health centres in order to be considered successful. This requires a more flexible system, with the dispersion of local analytical capabilities, better infrastructure and training, and filling of gaps in human resources.

In addition to these existing concerns, additional factors would need to be taken into account as the government makes a shift towards the use of big data in reproductive healthcare provisioning through the MCTS/RCH and Aadhaar infrastructure. **While earlier research has pointed towards the need for interoperability between completely disparate databases, there are several other concerns regarding exclusion of**

legitimate beneficiaries and informational privacy that need to be addressed. Such regulatory frameworks for reproductive HIS need to be put in place before implementation, taking into account purpose-specific consent, encryption and anonymisation of data, and limitations regarding sharing and use of data.

Finally, robust monitoring of health provision requires qualitative information on the nature of services being provided, which can **investigate social causes of poor reproductive health**. This also requires reproductive health to be conceptualised robustly, rather than as the absence of illness during and immediately after pregnancy. If not used only as evidence for 'return-on-investment' or as a tool to control women's bodies, reproductive health informatics has the potential to **disrupt the history of top-down policymaking to produce data that is locally relevant to grassroots actors.**