Zindagi Mehfooz (ZM) Electronic Immunization Registry in Pakistan

Apr 19, 2021

Maternal & Child Health, IRD
mch@ird.global
Scale Up & Status of the ZM EIR in Pakistan – Apr 20, 2021

**Gilgit District**
- 13,181+ Children
- 3,041+ Women
- 104,066+ Immunizations
- 41 Vaccinators
- 26 Immunization Clinics

**Islamabad**
- 16,304+ Children
- 1,876+ Women
- 85,611+ Immunizations
- 31 Vaccinators
- 40 Immunization Clinics

**Sindh**
- 4.6M + Children
- 1.6M + Women
- 45M + Immunizations
- 3,460 Vaccinators
- 1,752 Immunization Clinics

In 2020, ZM EIR enrolled 100% of the EPI estimated annual live birth cohort of Sindh

**Total**
- 10,334 Annual Birth Cohort
- 20,482 Annual Birth Cohort
- 47.9M Population
- 4.6M+ Children
- 1.6M+ Women
- 45M+ Immunizations
- 3,532 Vaccinators
- 1,818 Immunization Clinics

In 2019, ZM EIR enrolled 83% of the EPI estimated annual live birth cohort of Sindh excluding Districts Khairpur & Dadu

Islamabad Population & Birth Cohort are estimated based on catchment areas where ZM is active
ZM started in 2011 as a phone-based electronic immunization registry to improve immunization coverage and timeliness.
Timeline of ZM EIR (2011-2020)

- **2011**: UN Foundation Innovation working group award
- **2012**: Software Deployment started
- **2015**: Pilot deployment in Korangi, Karachi
- **2016**: Limited deployment in Shikarpur
- **2017**: Innovation award
- **2018**: Scale-up in Sindh
- **2019**: Scale-up support
- **2020**: ZM expansion to GB
- **2020**: Birth Registry
- **2020**: Piloting barcode & eVVM

**Commonwealth Digital Health Award**

- 2011: Joint UN Foundation Innovation working group award
- 2012: Pilot deployment in Korangi, Karachi
- 2015: Limited deployment in Hafizabad, Punjab
- 2016: Innovation award
- 2017: Scale-up in Sindh
- 2018: Scale-up support
- 2019: ZM expansion to GB
- 2020: Birth Registry
- 2020: Piloting barcode & eVVM

**Commonwealth Digital Health Awards**

- 2011: Commonwealth Digital Health Award
- 2012: Commonwealth Digital Health Award
- 2015: Commonwealth Digital Health Award
- 2016: Commonwealth Digital Health Award
- 2017: Commonwealth Digital Health Award
- 2018: Commonwealth Digital Health Award
- 2019: Commonwealth Digital Health Award
- 2020: Commonwealth Digital Health Award
How ZM Works

Enrollment: Child’s/ Woman’s biodata uploaded on the EIR and linked with the QR code on the EPI card

Child/ Woman approached for immunization

Course Completion: No further vaccines after Measles 2/ TT-5

SMS reminder for next scheduled vaccination

Form submitted to server

Follow-up: ID retrieved from QR code, vaccinators access individual child schedule

Data retrieved from server

Child/ Woman is vaccinated as indicated by the immunization decision support system
Key Features of the ZM EIR: an Android SuperApp for Vaccines

- QR code-based identification
- Web interface
- Mobile-based data entry & access
- Geopoint field to capture GPS coordinates
- Interactive SMS reminders
- Offline mode
- Child registry

- Built in iDSS for routine & catch-up immunization
- Attendance & GIS tracking of vaccinators
- Digital immunization certificate
- Micro-planning activities
- Defaulter list & reports
- Predictive Analytics
ZM EIR Campaign & Outreach Mode

Sign In
Username
Password
- Remember me

- Fixed
- Outreach
- Campaign
- Van

campaign Karachi
campaign Muzaffargarh
campaign Shikarpur
Measles Campaign 15-27 Oct

CHILD REGISTRY
INVENTORY
SAVED FORMS

ENROLLMENT
FOLLOW UP
ENROLLMENT

HOME
CHECK OUT

CAMPAIGN

- Child enrolled in Zindagi Mehfooz
- Bache ka naam nahi rakha gaya

Child’s Name
Father’s Name
Valid CNIC

Gender
- Male
- Female

Bache ki DOB ya umar
15/01/2020

- Calendar
- Age

District
- Karachi Central District
- Town/Taluka
- Union Council
**ZM EIR Child Enrollment & Registration**

### Biodata entry

**Data points**
- Child ID
- Child Name
- Father Name
- National ID #
- Child DOB

**Biodata details**
- Child ID: 2019000000013
- EPI Number: 20190001
- Has the child been given a name? [ ]
- Child's Name: [ ]
- Father's Name: [ ]
- Valid NIN: [ ]
- Gender: [ ] Male [ ] Female

### Address entry

**Data points**
- Community
- Town/City
- Union Council
- Address
- Nearby Landmarks

**Address details**
- Community: [ ]
- Town: [ ]
- Local Government Headquarters: [ ]
- Address: [ ]
- Nearby Landmarks: [ ]
Immunizations Super App – ZM EIR Child Data Variables

- Name
- Gender
- Date of birth
- Place of birth
- Household address
- Contact number
- Age at vaccination
- Caregiver’s National ID #
- Mother’s education
- Father’s name
- SMS reminders
- Modality (Fixed vs. outreach)
- Vaccination date
- Vaccination location
- Geo-location for each vaccination
Immunizations Super App – ZM EIR Vaccinator Data Variables

- Name & gender
- Centre name
- Vaccination route
- EPI ID
- Vaccination administration site (fixed vs outreach)
- Attendance
- QR Code
- Geo-location
EIR Unique Identification Response Code (QR Code)

**Unique ID** assigned to each woman and child in the form of a **QR Code** which can be scanned at every follow up, leading to **instant data retrieval**.
Unique Identification: ZM EIR Child Search Options

- QR code
- National ID #
- Father’s Name
- District Name
- Mobile Number
- Child Name
- Date of birth
- Child Gender
Automated SMS Reminders to Parents

**Reminder 1**
One day before due date

**Reminder 2**
On the due date

**Reminder 3**
6 days after the due date if child not immunized
SMS Chat for Questions, Concerns & Complaints

**COMPLAINTS**

“They are out of the pentavalent vaccine”

**ADVERSE EVENTS**

“Zain has developed a rash. What should we do?”

**VITAL EVENTS**

“Sadia has died”

**QUERIES & CONCERNS**

“Sadia is sick, how long is the due date?”

**INFORMATION**

“We have lost the card. Can we get another one?”
**ZM EIR Offline Mode**

Data entered during periods of low/no connectivity

Saved on the app through the Saved Forms options

Data uploaded once device is back online
### Defaulters Children List for Vaccination

**Province:** Larkana

#### Defaulters Information

<table>
<thead>
<tr>
<th>Identifier</th>
<th>Card Number</th>
<th>Name</th>
<th>Fathers Name</th>
<th>DOB On Age</th>
<th>Phone Number/Address</th>
<th>Number Of Defaulted Vaccines</th>
<th>Defaulted Vaccine</th>
<th>Defaulted Vaccine Due Date</th>
<th>Defaulted Date</th>
<th>Vaccination Status</th>
<th>Enrollment Center</th>
<th>Enrollment Vaccinator</th>
<th>Last Visited Center</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>20200600770815</td>
<td>20200600</td>
<td>Meenpur Warah Kamber District</td>
<td>01-08-2020</td>
<td>1</td>
<td>DCG</td>
<td>03-08-2026</td>
<td>31-08-2026</td>
<td>DEFAULTED</td>
<td>BHU Farsiabad</td>
<td>Abdul Kafi</td>
<td>BHU Farsiabad</td>
<td>Info</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20200600770805</td>
<td>20200600</td>
<td>Vizyan Wali KHAND JO GOTH Mehar Bada</td>
<td>01-08-2020</td>
<td>1</td>
<td>DCG</td>
<td>03-08-2026</td>
<td>31-08-2026</td>
<td>DEFAULTED</td>
<td>BHU Farsiabad</td>
<td>Abdul Kafi</td>
<td>BHU Farsiabad</td>
<td>Info</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20200600773476</td>
<td>20200600</td>
<td>Qurni Madi Meenpur Warah Kamber District</td>
<td>01-08-2020</td>
<td>1</td>
<td>DCG</td>
<td>03-08-2026</td>
<td>31-08-2026</td>
<td>DEFAULTED</td>
<td>BHU Farsiabad</td>
<td>Abdul Kafi</td>
<td>BHU Farsiabad</td>
<td>Info</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20200600525187</td>
<td>20200600</td>
<td>Ibrahim Laghri Khuda Khel Tambo Bago Baddi District</td>
<td>30-07-2020</td>
<td>1</td>
<td>DCG</td>
<td>03-08-2026</td>
<td>31-08-2026</td>
<td>DEFAULTED</td>
<td>BHU Wall Mohammad Malikani</td>
<td>Abdul Malique</td>
<td>BHU Wall Mohammad Malikani</td>
<td>Info</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20200600525186</td>
<td>20200600</td>
<td>Harji Rind Kheer Maroom Tambo Bago Baddi District</td>
<td>30-07-2020</td>
<td>1</td>
<td>DCG</td>
<td>03-08-2026</td>
<td>31-08-2026</td>
<td>DEFAULTED</td>
<td>BHU Wall Mohammad Malikani</td>
<td>Abdul Malique</td>
<td>BHU Wall Mohammad Malikani</td>
<td>Info</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20200600523105</td>
<td>20200600</td>
<td>-</td>
<td>30-07-2020</td>
<td>1</td>
<td>DCG</td>
<td>03-08-2026</td>
<td>31-08-2026</td>
<td>DEFAULTED</td>
<td>BHU Wall</td>
<td>Abdul</td>
<td>BHU Wall</td>
<td>Info</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The micro-planning feature boosts accountability and target achievement by helping to structure and monitor outreach activities.

- Scheduling outreach activities
- Assigning adequate resources
- Identifying target locations
- Goal to increase number of immunized children
Using Geospatial data to track a Child’s Immunization Progress

1. Child Name: Redacted
2. Father’s Name: Redacted
3. Gender: Female
4. DoB: 13-01-2018
5. Enrollment date: 09-02-2018
6. Enrollment age (in days): 27
7. Enrollment district: Korangi, Karachi
8. Residential city: Hyderabad
9. Mother’s education: Matric
10. Place of birth: Hospital

1. Landhi Medical Complex, Korangi
   - 27 Days
   - OPV-0, BCG

2. Landhi Medical Complex, Korangi
   - 106 Days
   - OPV-1, Penta-1, PCV-1

3. Karachi Central
   - 154 Days
   - OPV-2, Penta-2, PCV-2

4. BHU Darwaish Kakepota, Shikarpur
   - 288 Days
   - OPV-3, Penta-3, PCV-3, IPV

5. Majee Hospital Unit No 8, Hyderabad
   - 344 Days
   - Measles-1

6. Hyderabad Outreach
   - 456 Days
   - Measles-2
GSM Tracking for Vaccinators

GSM based GIS tracking to improve workforce monitoring for improved geographic coverage of immunization services
Features

- Real-time tracking
- Team view for simultaneous supervision of multiple teams
- Active surveillance system to ensure complete coverage
- Touch points to enable follow-up teams to locate refusal households
- Route view to monitor attendance and mobility of field staff
- Online mapping
- Live web dashboard for supervision
- Geo-fencing for effective coverage of remote areas
AI Powered Predictive Analytics to Prevent Missed Opportunities

Using logistic regression models, empirical data mining, and simulation models to accurately predict individual probability of incomplete immunization.

High Risk ( Likely to default )

Low Risk ( Likely to show up for follow-up immunization )

Immunization

Predictive Analysis

- Machine learning
- Artificial intelligence

Improve Routine Immunization Timeliness

Lower BCG to Measles Dropout Rate

Improve Immunization Equity

Identify Variables Correlating with High Drop-out Risk
Data Security and Confidentiality

Strict data sharing and access security, protection, and confidentiality in place

- Follows industry standards for authentication, encryption, and secure communication
- Pakistan based cloud storage
- Prevents unauthorized access
- Encryption of data in transit
- Logs of who downloads which reports
- Data sharing with third parties allowed only after written authorization
- Role-based access to the system, with degrees of clearance for data viewing, editing, and downloads
Pregnant Women and Birth Registration
Pregnant Women & Birth Registry

Hospital → Pregnant woman enrolled → OB/GYN

Newborn enrolled and given birth dose → Visit to fixed EPI centre → Child brought home

Linkage with Provincial EIR → Community workers are informed of the birth of the child in their catchment area

The designated Lady Health Worker (LHW) visits the child’s house and links the child to the area vaccinator

Child assigned to area vaccinator → Outreach activities
EIR Unique Identification Response Code (QR Code)

**Unique ID** assigned to each woman and child in the form of a **QR Code** which can be scanned at every follow up, leading to **instant data retrieval**

A unique QR Code is assigned to every woman & child

The QR code is pasted on the woman’s & child’s immunization card

The code is scanned at every visit for instant data retrieval
Case examples of Geo-spatial analysis using Big Data from ZM EIR
Using Geospatial Analysis at Macro and Micro Level

120,759 children missed follow-up immunizations during COVID-19 lockdown (Mar 23-May 9, 2020) and have not been covered.

- **Province**: 120,759 children missed follow-up immunizations during COVID-19 lockdown (Mar 23-May 9, 2020) and have not been covered.

- **District**: 9.5% of the total missed children are from District West, Karachi.

- **Town**: 2.9% of the total missed children are from Town Orangi.

- **Union Council**: 0.3% of the total missed children are from UC Dad Nagar.

Geo-locations of children missed during COVID-19 lockdown who have not been covered.

Every polygon represents a population of 10,000. The polygon is considered covered if a vaccinator has visited the population at least once in the month.
Cumulative catch-up coverage rate of children who missed* follow-up immunizations during the COVID-19 lockdown (Mar 23 – May 9, 2020) across Sindh Province, by month, and the heat map of uncovered children (n=417,553) Mar 23, 2020 – Mar 31, 2021

Children Missed during lockdown (n=417,553)

- 3.8% (15,920/417,553) children covered as of Apr 30, 2020
- 18.4% (76,680/417,553) children covered as of May 31, 2020
- 29.3% (122,430/417,553) children covered as of Jun 30, 2020
- 41.5% (173,313/417,553) children covered as of Jul 31, 2020
- 60.9% (254,335/417,553) children covered as of Aug 31, 2020
- 78.9% (329,492/417,553) children covered as of Sep 30, 2020
- 68.4% (285,432/417,553) children covered as of Oct 31, 2020
- 72.4% (302,401/417,553) children covered as of Nov 30, 2020
- 75.8% (316,630/417,553) children covered as of Dec 31, 2020
- 77.3% (322,836/417,553) children covered as of Jan 31, 2021
- 78.9% (329,492/417,553) children covered as of Feb 28, 2021
- 79.2% (330,650/417,553) children covered as of Mar 31, 2021

Out of the 417,553 children missed during the COVID-19 lockdown (Mar 23 – May 9, 2020) in Sindh, 79.2% have been covered as of Mar 31, 2021

* A child is categorized as missed if he/she has not received vaccination within 28 days of his/her vaccine due date.
Crude M:F ratio of children enrolled in ZM EIR, across Sindh (n=4,531,481)
Oct 2, 2017 – Feb 20, 2021

Province Sindh
Crude M:F ratio: **1.12**

District Ghotki
Crude M:F ratio: **1.18**

Legend
- District Boundary
- UC Boundary
- Data not available
- M:F ratio
  - 1.02 - 1.07
  - 1.07 - 1.08
  - 1.08 - 1.10
  - 1.10 - 1.12
  - 1.12 - 1.14
  - 1.14 - 1.15
  - 1.15 - 1.17
  - 1.17 - 1.19
  - 1.19 - 1.61
Crude M:F ratio among children vaccinated through outreach and fixed activities, outreach activity only during baseline (Sep 23, 2019 – Mar 22, 2020) and Enhanced Outreach Activity phase 16 (Feb 15-27, 2021), by district in Sindh Province

Outreach and Fixed Activities during baseline
(n=1,566,384)
Crude M:F ratio: 1.09 (range: 0.60-2.87)

Outreach during baseline
(if child has received >=50% vaccines through outreach as compared to fixed sites)
(n=799,314)
Crude M:F ratio: 1.08 (range: 0.40-2.78)

Phase 16 of Enhanced Outreach Activity
(n=304,410)
Crude M:F ratio: 1.08 (range: 0.42-2.50)

EOA phase 16 was conducted in 27 out of 29 Districts in Sindh excluding Districts Khairpur & Dadu
Children under 2 years of age who missed follow-up immunization visits during COVID-19 lockdown (Mar 23 - May 9, 2020) and have not been covered, per 5 km radius (n=86,903) Mar 23, 2020 - Mar 31, 2021

64.0% (21/33) of the biggest hotspots with at least 400 missed children are concentrated in Division Karachi
R&D Features in ZM
Interactive, Game-based Trainings to Boost Vaccinator Performance

Through the ZM EIR, vaccinators across Sindh can access digital, game-based learning modules to receive on-job training, access refresher courses and learn new information.

- Story-based videos
- Multiple choice questions for each chapter
- Friendly Competition/Leaderboard
- Peer to peer communication
Stock Supply and Cold Chain
Generating Accurate Vaccine Consumption Data And Vial-to-Child Linkage

Innovative 2D bar codes with eVVM

Automated Instant interpretation for vaccinator + EIR record linking vial-to-child
Vial to Child Link in ZM EIR

Leveraging existing digital technologies to merge supply-side **barcoded vaccine vials** with service-delivery-side **barcoded immunization cards**

- **Vaccine with 2D serialized barcode + eVVM**
- **Real-time Child immunization in ZM EIR**
- **Vial to child**
Bablibot – ZM integrated AI Chatbot
Better Delivery of Immunization Information to Caregivers

Development

- Development of chatbot using AI, NLP and HITL technologies

Integration

- Integration with the ZM Registry for data retrieval

BabliBot

- Immunization Center Information
- Individual Immunization Queries
- Soliciting caregiver feedback
- Care for Adverse Events
- Health education
Thank you

Maternal & Child Health Program
mch@ird.global

Picture: Vaccine administration in a super high-risk UC through a Mobile Immunization Van.