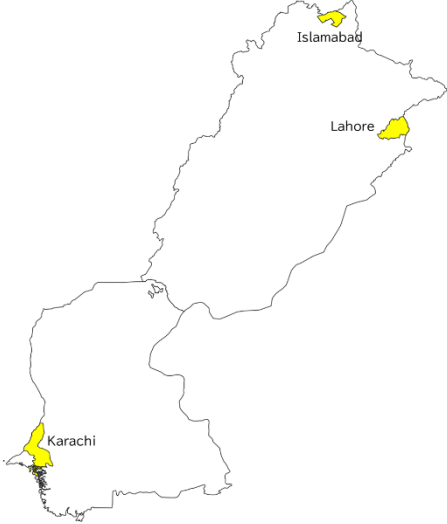


## FY2024 Simplified Ex-Post Evaluation Report of Japanese Grant Aid Project

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Duration of the Study: November 2024 – January 2026

Duration of the Field Study: April 19 – May 2, 2025

|                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                        |
|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| Country Name                                                                      | <b>The Project for Installation of Weather Surveillance Radar at Karachi</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                        |
| Islamic Republic of Pakistan                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                        |
|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                      |
| Location of the Project site (source: Prepared by the evaluator)                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Karachi Meteorological Radar Tower Facility (source: Supplementary Materials to the Completion Report) |
| <b>I. Project Outline</b>                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                        |
| Background                                                                        | <p>In Pakistan, natural disasters such as floods and cyclones occur frequently, with large-scale events exemplified by the 2010 Indus River flood. In particular, during the monsoon season (June–October) and the cyclone seasons (May–June and October–November), heavy rainfall and strong winds are common, making the development of an effective radar system essential for accurate meteorological monitoring. At the time of Project planning, the Karachi Meteorological Radar played a crucial role as a key facility for early warning and response to tropical cyclones and other weather-related disasters in southern Pakistan. However, the radar had become severely deteriorated due to aging, and there were concerns that it could cease to function completely within a few years. If the radar were to stop operating, the country would lose a critical means of monitoring meteorological phenomena that could lead to disasters. Given these circumstances, the replacement of the Karachi Meteorological Radar was recognized as an urgent priority to maintain and strengthen disaster prevention and preparedness systems in the southern region.</p> |                                                                                                        |
| Objectives of the Project                                                         | <p>To enhance the meteorological observation capabilities of the Pakistan Meteorological Department through the upgrading of the Karachi Meteorological Radar System, which has become dysfunctional due to aging, thereby contributing to the reduction of damage from natural disasters such as cyclones and floods, the assurance of human security, and the improvement of social infrastructure in Pakistan.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                        |
| Contents of the Project                                                           | <ol style="list-style-type: none"> <li>1. Project Site: Karachi, Islamabad, and Lahore</li> <li>2. Japanese side: <ol style="list-style-type: none"> <li>(1) Meteorological Radar Tower (1 unit)<br/>Installation site: Karachi Meteorological Office</li> <li>(2) Meteorological Radar Data Display System<sup>2</sup><br/>Installation sites: <ol style="list-style-type: none"> <li>(a) Karachi Meteorological Radar Tower</li> <li>(b) Tropical Cyclone Warning Centre (hereinafter referred to as “TCWC”), Karachi</li> <li>(c) Meteorological Office at Karachi International Airport</li> <li>(d) National Weather Forecasting Center (hereinafter referred to as “NWFC”)</li> <li>(e) Meteorological Office at New Islamabad International Airport</li> <li>(f) Flood Forecasting Division (hereinafter referred to as “FFD”), Lahore</li> </ol> </li> <li>(3) Others <ol style="list-style-type: none"> <li>(a) Consulting services: Detailed design, construction supervision, etc.</li> <li>(b) Soft component: Training on radar observation, operation, and maintenance</li> </ol> </li> </ol> </li> </ol>                                                          |                                                                                                        |

<sup>1</sup> Working in a reinforcement role from Metrics Work Consultants, Inc.<sup>2</sup> It is a system for analyzing and visualizing the radar data obtained and is installed at meteorological observation centers and operational sites.

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |              |                 |                                        |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------|----------------------------------------|
|                         | 3. Pakistan side:<br>(1) Site preparation and leveling of the construction area<br>(2) Installation of commercial power lines from the main grid to the Karachi Meteorological Radar Tower Facility<br>(3) Establishment of a Virtual Private Network (VPN) necessary for transmitting observation data from the Karachi meteorological radar system<br>(4) Provision of a reliable and high-speed internet environment<br>(5) Assignment of IP addresses to supply equipment (PC and peripheral devices), etc. |              |                 |                                        |
| Implementation Schedule | E/N Date                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | July 8, 2015 |                 |                                        |
|                         | G/A Date                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | July 8, 2015 | Completion Date | November 5, 2021<br>(Date of Handover) |
| Project Cost            | E/N Grant Limit / G/A Grant Limit: 1,949 million yen, Actual Grant Amount: 1,841 million yen                                                                                                                                                                                                                                                                                                                                                                                                                    |              |                 |                                        |
| Executing Agency        | Pakistan Meteorological Department (hereinafter referred to as “PMD”)                                                                                                                                                                                                                                                                                                                                                                                                                                           |              |                 |                                        |
| Contracted Agencies     | Main Contractors: Mitsubishi Corporation / Tobishima Corporation (JV)<br>Main Consultants: Japan Weather Association / International Meteorological Consultant Co., Ltd. (hereinafter referred to as “IMC”) (JV)                                                                                                                                                                                                                                                                                                |              |                 |                                        |

## II. Result of the Evaluation

### Summary

The Project was implemented to enhance the meteorological observation capabilities of the PMD, through upgrading the Karachi Meteorological Radar, which had become dysfunctional due to aging, thereby reducing damage caused by natural disasters such as cyclones and floods, and contributing to the assurance of human security and the improvement of social infrastructure in Pakistan.

The Project was consistent with Pakistan’s development policies and disaster management needs at the time of implementation, as well as with Japan’s ODA Policy. In addition, synergy was achieved through coordination with JICA’s other technical cooperation projects. The Project’s relevance and consistency are overall rated as high.

Regarding effectiveness, the Project achieved its targets for key indicators such as wind speed observation, rainfall detection range, accumulated rainfall data, spatial resolution, and gradation. The observation performance of the Karachi Meteorological Radar was significantly improved. In particular, the upgraded radar enabled earlier detection, detailed monitoring, and more accurate trajectory prediction of extreme weather events such as cyclones, contributing to timely issuance of warnings and promotion of evacuation during disasters. For example, during Cyclone “Biparjoy” in 2023, early warnings based on radar observations helped prompt evacuation of residents. Accordingly, the Project’s effectiveness and impact are high.

As for efficiency, although the Project cost was within the plan, the Project period was significantly exceeded the plan. Therefore, efficiency of the Project is moderately low.

Regarding sustainability, institutional, technical, and human resource aspects are generally favorable. The Radar Operations Division maintains stable 24-hour operations through system monitoring, preparation of inspection manuals, and implementation of in-house training and on-the-job training (OJT). Although the operational cost has increased to five to six times the initial estimate due to rising electricity prices, flexible operational adjustments have been made—such as reducing operation during the dry season when rainfall is low and operating almost continuously during the monsoon season. Furthermore, no major malfunctions hindering operations have occurred to date, and large-scale repairs are not anticipated. Based on these factors, sustainability is considered to have no major issues.

In light of the above, the Project is evaluated to be highly satisfactory.

| Overall Rating <sup>3</sup> | A | Relevance & Coherence | ③ <sup>4</sup> | Effectiveness & Impacts | ③ | Efficiency | ② | Sustainability | ③ |
|-----------------------------|---|-----------------------|----------------|-------------------------|---|------------|---|----------------|---|
|-----------------------------|---|-----------------------|----------------|-------------------------|---|------------|---|----------------|---|

<Special Perspectives Considered in the Ex-Post Evaluation/Constraints of the Ex-post Evaluation>

- To measure the achievement level of the Project’s outcome—improvement of meteorological observation capability—an additional indicator was set at the time of the ex-post evaluation. Specifically, the indicator examined whether the quality of meteorological observation had improved as a result of the replacement of the Karachi Meteorological Radar. The evaluation assessed the extent of performance enhancement after the upgrade and analyzed how such improvement contributed to the overall quality of meteorological observation.
- To check whether residents in Karachi had access to meteorological information and recognized that such information contributed to reducing the damage caused by weather-related disasters, a simplified resident interview survey was conducted. The survey sample was selected from communities belonging to lower-income groups, ensuring a balance between male and female respondents, with a particular focus on residents living near riverbanks who are considered highly vulnerable to natural disasters such as floods. Specifically, 20 households residing along the Malir River basin were interviewed. In consideration of security concerns, the interviews were conducted solely by local consultants who were well acquainted with local conditions.

<sup>3</sup> A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

<sup>4</sup> ④ : Very High ③: High, ②: Moderately low, ①: Low

## 1 Relevance/Coherence

### <Relevance>

#### ▪ Consistency with the Development Policy of Pakistan at the Time of Ex-Ante

The Project is highly consistent with Pakistan's medium- to long-term development policies and disaster risk reduction strategies. First, under *Vision 2025* (2014–2025), the establishment of sustainable water-related disaster resilience is identified as a national priority. The upgrading of the meteorological radar system under the Project contributes to the realization of this policy by strengthening the country's capacity to monitor meteorological disasters.

In addition, the *National Disaster Management Plan* (2012–2022) explicitly calls for the development of meteorological radar systems and the expansion of water level observation networks as part of its disaster intervention measures, directly aligning with the objectives and components of the Project.

Furthermore, the *Multi-Hazard Early Warning Plan* (2012–2022) identifies the enhancement of meteorological forecasting capacity and the establishment and strengthening of early warning and dissemination systems as key strategies. The Project's objectives—improving meteorological observation capacity and contributing to disaster risk reduction—are thus fully consistent with these strategic goals.

#### ▪ Consistency with the Development Needs of Pakistan at the Time of Ex-Ante

At the time of ex-ante evaluation, Pakistan was frequently affected by meteorological disasters such as floods and cyclones, and strengthening the monitoring system—particularly in the southern region—was an urgent issue. The Project, which aimed to replace the aging Karachi Meteorological Radar, is therefore consistent with the country's development needs in the field of disaster risk reduction.

### <Coherence>

#### ▪ Consistency with Japan's ODA Policy at the Time of Ex-Ante Evaluation

The *Country Assistance Policy for Pakistan* (2012) identifies “ensuring human security and improving the social infrastructure” as one of its priority areas, within which “support for disaster risk reduction” is positioned as a key development issue. The Project, which aims to strengthen early warning capacity for meteorological disasters, is consistent with the objectives of this policy and contributes to the protection of human lives and the promotion of sustainable development through disaster risk reduction.

#### ▪ Internal Coherence

The Project demonstrated a high degree of internal coherence with other JICA projects. Specifically, from the time of ex-ante evaluation, it was planned to utilize the network established under the Grant Aid Project “The Project for Establishment of Specialized Medium Range Weather Forecasting Center and Strengthening of Weather Forecasting System”<sup>5</sup> (2014–2020) to transmit observation data from the Karachi Meteorological Radar to the National Weather Forecasting Center (NWFC) in Islamabad and other relevant locations.

In practice, through the data communication system introduced under the Project, radar data from Karachi have been transmitted to multiple sites, including the Tropical Cyclone Warning Centre (TCWC), the Meteorological Office at Karachi International Airport, and the NWFC. The VPN servers developed through the aforementioned grant aid project have been effectively utilized as part of the communication infrastructure. As a result, tangible operational achievements have been observed in areas such as cyclone monitoring, maritime surveillance, and air traffic control. The synergy between the two projects has further enhanced the overall effectiveness of the Project.

#### ▪ External Coherence

At the planning stage of the Project, the TCWC was disseminating information to vessels around the world via the International Maritime Satellite (INMARSAT) system. It was expected that the enhanced observational capabilities of the Radar through this Project would enable the TCWC to fulfill this international responsibility with greater accuracy and thereby contribute to improved maritime safety.

### <Evaluation Result>

In light of the above, the relevance and coherence of the Project are high<sup>6</sup>.

## 2 Efficiency

Although minor modifications were made, all output was generally produced as planned<sup>7</sup>. In addition, according to the PMD, the obligations to be borne by the Pakistani side were also fulfilled as planned.

The total Project cost amounted to 1,874 million yen, compared with the planned 1,977 million yen, remaining within the planned budget (95% of the plan). Of this total, the Japanese side accounted for 1,841 million yen against the planned 1,940 million yen (94% of the plan), while the Pakistani side contributed 33 million yen against the planned 37 million yen (90% of

<sup>5</sup> In Pakistan, the meteorological disasters such as heavy rainfall, floods, and cyclones occurred frequently because of climate change, making it an urgent priority to strengthen medium-range forecasting capabilities (ranging from several days to about ten days). The Project aimed to enhance the country's meteorological forecasting capacity and information dissemination system through the establishment of the Specialized Medium Range Forecasting Centre (hereinafter referred to as “SMRFC”), as well as through support for numerical weather prediction systems, communication networks, and human resource development.

<sup>6</sup> Relevance: ③, Coherence: ③

<sup>7</sup> Minor design changes were made regarding the foundation structure, water supply connection, and equipment specifications, all of which were implemented with JICA's approval. (Source: JICA-provided materials)

the plan)<sup>8</sup>.

The planned Project period was 37 months (from September 2015 to September 2018), but after two extensions, it was finally prolonged to 78 months (from July 2015 to December 2021). The actual completion was in November 2021.

The extension of the G/A grant period from December 2020 to December 2021 was mainly due to the postponement of on-site work during the rainy season because of the impact of the COVID-19 pandemic, which prevented the implementation of technical guidance scheduled for the final monsoon season and resulted in the postponement of on-site work during that period. Considering this external factor, the actual implementation period—excluding the 13 months affected by the pandemic—can be regarded as 65 months, equivalent to 176% of the originally planned duration, indicating that the Project significantly exceeded the initial plan.

#### <Evaluation Result>

Therefore, efficiency of the project is moderately low.

### 3 Effectiveness/Impacts<sup>9</sup>

#### <Effectiveness>

##### Achievement of Operational and Effectiveness Indicators

The indicators established to measure the achievement of the Project's outcome—enhancement of meteorological observation capacity—and their actual performance are shown in the table below. Since the completion of the Project, there have been no cases of long-term suspension of the Karachi Meteorological Radar due to malfunction or other reasons, nor have there been any instances where the Radar failed to respond during disasters. Following the Radar's replacement, all key indicators—including wind velocity observation, rainfall detection range, accumulated rainfall data acquisition, spatial resolution, and gradation levels—have shown significant improvement compared with the baseline year, achieving or exceeding the target levels.

#### Quantitative Effects

| Indicators                                                                                                          | Baseline<br>2015<br>Baseline Year | Target<br>2021<br>3 Years after<br>Completion | Actual<br>2021<br>Completion<br>Year | Actual<br>2022<br>1 Year after<br>Completion | Actual<br>2023<br>2 Years after<br>Completion | Actual<br>2024<br>3 Years after<br>Completion |
|---------------------------------------------------------------------------------------------------------------------|-----------------------------------|-----------------------------------------------|--------------------------------------|----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| Observation of wind velocity up to 75 m/s within a 200 km radius of Karachi                                         | Not available                     | Achieved                                      | Achieved                             | Achieved                                     | Achieved                                      | Achieved                                      |
| Rainfall detection range (for rainfall intensity $\geq 1$ mm/h) by the Karachi meteorological radar (radius, km)    | 350                               | 450                                           | 450                                  | 450                                          | 450                                           | 450                                           |
| Hourly accumulated rainfall data obtained by the Karachi meteorological radar                                       | Not available                     | Achieved                                      | Achieved                             | Achieved                                     | Achieved                                      | Achieved                                      |
| Spatial resolution and observation interval of rainfall data by the Karachi meteorological radar (average mesh, km) | 81.9                              | 2.5                                           | 2.5                                  | 2.5                                          | 2.5                                           | 2.5                                           |
| Number of gradations of rainfall data by the Karachi meteorological radar                                           | 6                                 | 256                                           | 256                                  | 256                                          | 256                                           | 256                                           |

Source: PMD questionnaire responses and interview with PMD

<sup>8</sup> Source: PMD-provided materials

<sup>9</sup> When providing the sub-rating, Effectiveness and Impacts are to be considered together.

### Supplementary Indicator: Improvement in performance after the upgrade and its contribution to the quality of meteorological observation

Before the upgrade, the aging of the Karachi Meteorological Radar made it difficult to conduct high-precision observations of wind speed and rainfall. In particular, there were challenges in the early detection and detailed monitoring of cyclones. After the upgrade, the Radar became capable of observing wind speeds of up to 75 m/s and acquiring high-resolution rainfall data, enabling more accurate monitoring of cyclone intensity and tracking of their paths.

The table below summarizes the key functional improvements before and after the upgrade and the resulting enhancements in the quality of meteorological observation. Through this upgrade, the Karachi Meteorological Radar achieved significant improvements in major performance aspects, including wind speed observation, rainfall detection range, spatial resolution, gradation levels, and three-dimensional observation capability. Consequently, the quality of meteorological observation has been greatly enhanced, particularly in terms of early detection of extreme weather phenomena, accurate understanding of cyclone intensity and trajectories, and timely issuance of weather warnings.

Table 1. Improvements in Observation Functions through the Karachi Meteorological Radar Upgrade

| Function                                                                 | Issues before the Upgrade                                                                                          | Improvements after the Upgrade                                                       | Enhanced Observation Quality                                                                                            |
|--------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Wind speed observation capability                                        | Doppler wind observation <sup>10</sup> was not possible due to radar aging; only manual observation was available. | Improved to enable automatic observation of high wind speeds up to 75 m/s.           | Accurate understanding of cyclone intensity and wind structure.                                                         |
| Rainfall detection range                                                 | Detection range was limited to a radius of 350 km, insufficient for long-distance monitoring.                      | Detection range expanded to 450 km, capable of detecting rainfall of 1 mm/h or more. | Enables early detection and long-term tracking of cyclones.                                                             |
| Spatial resolution and observation interval of accumulated rainfall data | Coarse resolution (average 81.9 km mesh) with 3-hour intervals, lacking immediacy.                                 | Improved to approx. 2.5 km mesh with observations every few minutes.                 | Allows detailed monitoring of cyclone internal structure and rainfall patterns.                                         |
| Gradation levels of rainfall data                                        | Limited to 6 gradations, enabling only qualitative understanding; quantitative assessment was difficult.           | Improved to 256 gradations, allowing precise display from 0 to 250 mm/h.             | Enables accurate quantitative rainfall forecasting, warning issuance, flood prediction, and evacuation decision-making. |
| Three-dimensional observation (e.g., CAPPI <sup>11</sup> )               | Only horizontal-plane observation was possible; vertical cloud structure could not be captured.                    | Improved to generate CAPPI through multi-elevation-angle observation.                | Enables real-time monitoring of cyclone 3D structure and development status.                                            |

Source: PMD questionnaire responses and interview with PMD

#### <Impacts>

##### • Manifestation of Impact

From the time of ex-ante evaluation, the Project was expected to contribute to the reduction of damage caused by natural disasters such as cyclones and floods, as well as to the assurance of human security and improvement of social infrastructure in Pakistan.

In practice, during Cyclone “Biparjoy” in June 2023, high-precision observation and early warning enabled by the Karachi Meteorological Radar facilitated evacuation actions and helped reduce human casualties. Radar data were also utilized to enhance flood forecasting models and cyclone track prediction, providing valuable information for pre-disaster measures—particularly in the southern Sindh Province, which lies directly in the cyclone path and faces high disaster risk. Furthermore, enhanced marine monitoring capability enabled vessels to avoid dangerous sea areas, contributing to reduced risks of cyclone impacts and high-wave disasters.

Results from the household survey indicated that 95% of respondents recognized that meteorological information helped them avoid disaster damage, confirming the usefulness of such information. This is partly attributable to the relatively easy access to weather information in Karachi through television, radio, and mobile phones. However, the survey also revealed room for improvement in the accuracy and timeliness of information<sup>12</sup>. Specifically, although all respondents reported receiving weather information from PMD through mobile applications, social media, or television, only about 25% considered the information to be “accurate and timely.” In addition, while 95% of respondents felt that the information was at least somewhat helpful in

<sup>10</sup> Unlike conventional weather radars, which observe the location and intensity of rainfall, Doppler weather radars can measure the movement direction and velocity of precipitation particles by analyzing changes in radio wave frequency (the Doppler effect).

<sup>11</sup> CAPPI (Constant Altitude Plan Position Indicator) refers to a radar imaging function that provides a horizontal cross-sectional view at a constant altitude, allowing for three-dimensional understanding of cloud and rainfall structures.

<sup>12</sup> However, the present survey has the following limitations. For this ex-post evaluation, a simple interview survey was conducted with a total of 20 residents (11 men and 9 women), randomly selected from households living along the Malir River in Karachi, with consideration for gender balance. However, due to security concerns and time constraints during the field survey, only one local consultant, familiar with the local conditions, was available to conduct the interviews. Therefore, the sample size was small, and it should be noted that the results have limitations in terms of generalizability.

avoiding damage, few considered it “fully reliable,” with most stating that it was “somewhat helpful.” Particularly during extreme weather events such as heavy rainfall and cyclones, respondents expressed stronger needs for greater accuracy and faster dissemination of information.

The following section describes the specific impacts confirmed at the time of the ex-post evaluation.

#### Contribution of Cyclone Monitoring<sup>13</sup>

During Cyclone “Biparjoy,” the Karachi Meteorological Radar captured the structure of the cyclone’s eye and rainfall distribution at high resolution. The data were used for early warning and evacuation advisories, which helped prompt the evacuation of tens of thousands of residents, contributing to the minimization of human casualties.

#### Contribution to the Improvement of Maritime Safety<sup>14</sup>

At sea, where the installation of Automatic Weather Stations (hereinafter referred to as “AWS”)<sup>15</sup> is difficult, radar and satellite-based monitoring play a crucial role. With the upgrade of the Karachi Meteorological Radar, information sharing from PMD to the Marine Department has been strengthened. In particular, the improved accuracy of cyclone early detection and track forecasting has enabled ships to avoid hazardous sea areas in advance, thereby contributing concretely to the reduction of disaster risks at sea.

#### Contribution to Ensuring Human Security and Improving Social Infrastructure

According to interviews conducted with residents in Karachi, all respondents received weather forecasts from PMD through mobile applications, social media, or television. Moreover, 95% (19 out of 20 respondents) stated that the information was “at least somewhat useful” in avoiding damage during weather-related disasters. Many reported that they refrained from going out or moved to safer locations based on the information received, indicating that meteorological information contributed to improved community safety and disaster preparedness.

#### • Other Positive and Negative Impacts

##### Impacts on the Environment

In accordance with the *JICA Guidelines for Environmental and Social Considerations* (April 2010), the Project was classified as Category C, as it was judged to have minimal or no adverse environmental impacts. In practice as well, according to PMD, no negative environmental effects attributable to the Project were observed during implementation or after completion.

##### Impacts on the Social Environment (Land Acquisition and Resettlement)

At the time of ex-ante evaluation, no land acquisition or resettlement associated with the Project was anticipated. According to PMD’s reports, no such cases occurred during actual implementation.

##### Impacts on Gender Equality, Marginalized People, Social Systems and Norms, People’s Well-being and Human Rights

The Project is evaluated to contribute to ensuring the safety of residents in disaster-prone areas, particularly among vulnerable groups such as the poor and socially marginalized, thereby indirectly promoting gender equality, social inclusion, human rights, and overall well-being.

During Cyclone “Biparjoy,” high-precision radar observations and early warning dissemination encouraged evacuation among vulnerable groups, including women and the elderly, contributing to their safety. Furthermore, results from the resident survey indicated that many residents accessed meteorological information via mobile applications, television, and social media, and used this information to evacuate or avoid going out, confirming a certain level of equity in information access.

#### <Evaluation Result>

Therefore, the effectiveness and impacts of the Project are high.

#### 4 Sustainability<sup>16</sup>

##### • Policy and System

The sustainable utilization of the Meteorological Radar system established under the Project has been clearly positioned within Pakistan’s national policies and related institutional frameworks, and policy-level support is generally ensured. Specifically, the *National Disaster Management Plan (NDMP-2025)* formulated in 2024 identifies the advancement of early warning systems as a key priority, emphasizing the enhancement of multi-hazard early warning systems using AWS, meteorological radar, upper-air observation, and satellite monitoring. Likewise, the *National Flood Protection Plan IV (2017–2027)*, updated in 2024, incorporates measures to strengthen rainfall monitoring and improve flood forecasting capacity through the expansion of the meteorological radar network.

##### • Institutional/Organizational Aspect

At the time of ex-ante evaluation, the Karachi Meteorological Office was planned to have 36 personnel assigned to operate and maintain the Radar. At the time of the ex-post evaluation, however, the “Radar Operations Division,” established under the Karachi Chief Meteorologist, had a total of 14 staff members (one Director and 13 technical officers) operating and maintaining

<sup>13</sup> Interview with TCWC

<sup>14</sup> Source: Interviews with IMC and the Meteorological Office at Karachi International Airport

<sup>15</sup> An instrument that automatically and continuously observes and records data such as temperature, humidity, wind speed and direction, atmospheric pressure, and precipitation. It is widely used for meteorological monitoring in remote or uninhabited areas.

<sup>16</sup> Source: Interviews with IMC, PMD questionnaire responses, and interview findings

the system on a 24-hour basis. These staff members represent multiple technical specialties, ensuring the availability of the human resources necessary for radar operation and maintenance<sup>17</sup>.

Through this structure, regular maintenance is conducted on a daily, weekly, monthly, semiannual, and annual basis, and no operational disruptions due to personnel shortages have been reported. The difference in staffing figures from the ex-ante evaluation was confirmed to have resulted from the inclusion of non-observation personnel in the original plan; thus, it is considered that the number of radar-dedicated personnel is adequate.

In addition, radar image monitoring is shared among several offices equipped with radar display systems—including the TCWC (Tropical Cyclone Warning Centre)—as described in Section I (“Project Outline – Contents of the Project”), ensuring that the overall organizational monitoring system is functioning.

Based on the above, it is assessed that the operational framework supporting the sustainability of the Project’s outcomes is generally sufficient in both institutional and organizational aspects.

#### • Technical Aspect

The technical staff of PMD are composed of personnel holding bachelor’s or associate degrees in electronic engineering, ensuring an autonomous system for daily operation and maintenance. Organizationally, these staff members are primarily categorized as Electronic Engineers—those with bachelor’s degrees serving as Senior or Electronic Engineers, and those with associate degrees assigned as Assistant or Junior Electronic Engineers.

In addition, to maintain and enhance technical proficiency, in-house training sessions are conducted every six months, covering topics such as radar operation, troubleshooting, and handling of power supply systems. New staff members receive on-the-job training (OJT) to facilitate the transfer of technical knowledge, ensuring the continuity of capacity development within the organization.

Furthermore, comprehensive and systematically organized manuals are available at the Karachi Meteorological Radar Tower, covering the Radar, data display equipment, and peripheral devices. These manuals are regularly referenced during routine operations and troubleshooting and include standardized procedures for system start-up and shutdown, as well as checklists for daily, weekly, monthly, and annual inspections. Moreover, these operations are primarily managed by the Radar Operations Division of the Karachi Meteorological Office, which ensures stable management on a 24-hour basis based on these standardized procedures.

Given these factors, it is assessed that the technical foundation necessary for sustaining the functionality and effectiveness of the facilities, equipment, and systems introduced under the Project is well established.

#### • Financial Aspect

For the Karachi Meteorological Radar, the annual electricity cost, originally estimated at approximately PKR 1 million at the time of ex-ante evaluation, has increased to PKR 5.5–6 million per year as of 2025 due to rising electricity tariffs—about five to six times higher than initially projected. To address this, operation is optimized by reducing use during the dry season and prioritizing the monsoon period. According to interviews with PMD personnel, the dedicated staffing structure for the radar has been stable, and personnel costs have been covered within the regular budget. Although expenses for major repairs and periodic inspections are not included in the current budget—requiring separate government budget requests when needed—significant repairs or equipment replacements are not anticipated at this stage. Therefore, no major concerns are identified.

The Radar Data Display Systems installed at each site are maintained within the local PMD offices’ annual budgets, and because of their relatively low maintenance costs, both field observations and stakeholder interviews confirmed that they are operating smoothly without financial difficulty. Necessary maintenance funds are secured, and no significant financial concerns were identified.

#### • Environmental and Social Aspect

The Project was classified as Category C under the *JICA Guidelines for Environmental and Social Consideration* (April 2010), as it was determined to have minimal or no adverse environmental impacts. In practice, according to the PMD, no negative environmental impacts attributable to the Project were identified during either the implementation or post-completion stages.

Furthermore, no significant environmental or social impacts have been reported since the Project’s completion. Field investigations and interviews with relevant organizations also confirmed that no environmental or social issues have arisen because of the Project.

#### • Preventative Measures to Risks

In the Project, neither the ex-ante evaluation sheet nor the preparatory survey report explicitly identified any specific risks related to sustainability. During implementation as well, no major incidents occurred that required special measures to address risks anticipated at the planning stage, and no noteworthy response cases were reported.

#### • Current Status of Operation and Maintenance

The operation and maintenance system established for the Karachi Meteorological Radar under the Project was generally sound at the time of the ex-post evaluation. Regular maintenance activities were appropriately implemented based on a hierarchical inspection schedule—daily, weekly, monthly, and annual checks. Inspection records included signature fields for responsible

<sup>17</sup> At the time of ex-ante evaluation, the total of 36 personnel included not only the 22 staff members of the Radar Operations Division (comprising one Senior Electronic Engineer, three Electronic Engineers, one Assistant Electronic Engineer, twelve Technicians, one Technical Assistant, and four junior staff) but also 14 personnel from the Development Division (including one Senior Electronic Engineer, three Electronic Engineers, six Technicians, and four junior staff).

staff, ensuring accountability and proper documentation management. No reports of prolonged downtime or major functional failures were identified, confirming the PMD's stable operation of the radar (Photo ①).

Regarding equipment condition, incidents such as a power supply unit ignition<sup>18</sup>, failures of Transmitter/Receiver limiters<sup>19</sup> (hereinafter referred to as "T/R") (Photo ②), and fan unit<sup>20</sup> malfunctions reported since 2022 were all addressed promptly, avoiding serious impacts. Although one of the fan units replaced in 2022 continues to display a "not operating" error on the monitoring system, no physical malfunction has been identified, and the cause remains unknown, with a software-related issue suspected. While no functional problems have been observed to date, continued monitoring is required.

Regarding spare-parts management, most consumables and major components have been stocked and are generally well managed. However, for the T/R limiter, strengthening the procurement framework is desirable to prepare for potential future failures. Given the constraints on foreign-currency procurement, securing procurement routes in local currency and exploring the possibility of establishing a local distributor for the Japanese manufacturer remain important considerations<sup>21</sup>.

Overall, while some points warrant attention, no major issues have been identified at this stage, and the operation and maintenance arrangements of the Project are therefore assessed as generally sound.

#### <Evaluation Result>

Therefore, the sustainability of the Project effects is high.

### III. Recommendations & Lessons Learned

#### ▪ Recommendations to Executing Agency

##### Identifying the Cause of and Implementing Permanent Measures for Fan Unit Display Errors

**Issue:** For some of the fan units replaced in 2022, an error message indicating that they are "not operating" continues to appear on the monitoring system. No physical malfunction has been identified, and the cause remains unknown, though a software-related issue is suspected. If this situation is not resolved, it may hinder the early detection of actual malfunctions in the future.

**Recommendation:** By the end of FY2025, the PMD Karachi Office should cross-check and analyze monitoring system logs against hardware diagnostic results to identify the root cause of the display errors. If no physical issues are found, the Office should review and adjust software parameters and detection algorithms as necessary and consider introducing remote diagnostic tools if necessary.

#### ▪ Recommendations to JICA

None

#### ▪ Lessons Learned

##### Institutionalizing Maintenance Contracts and Local Procurement Channels in Projects Involving Long-Term Equipment Use

(Applicable to: JICA Grant Aid projects in countries with foreign currency restrictions, particularly those involving the provision of hardware equipment)

In the Project, issues emerged in the maintenance of equipment intended for long-term use—such as the Meteorological Radar—after the grant aid period. Because no long-term maintenance contract had been established, identifying the causes of equipment failures and obtaining technical support became difficult. Furthermore, in Pakistan, where foreign currency transactions are restricted, no procurement route in local currency had been secured, raising concerns that future spare parts procurement may require significant time and cost.

Based on this experience, for hardware equipment expected to be used for over a decade (e.g., Meteorological Radars, medical devices, water treatment systems), the following elements should be institutionally incorporated from the Project formulation and design stages:

- Conclusion of long-term maintenance contracts (covering fault diagnosis, remote technical support, software updates, and spare parts supply)
- Establishment of local-currency procurement routes through authorized agents in countries where foreign currency transactions are restricted

For similar projects in countries with foreign exchange restrictions such as Pakistan, Bangladesh, and Sudan, JICA, the implementing agencies, and manufacturers should work collaboratively—under a phased and clearly defined division of responsibilities that includes implementation support teams—to pre-establish a sustainable procurement framework and support mechanism. This will be crucial for ensuring the continued utilization and sustainable operation of the equipment.

### IV. Non-Score Criteria

#### ▪ Performance

#### ▪ Objective Perspective

<sup>18</sup> The incident was caused by overvoltage and voltage fluctuations in the electricity supplied by the power company. However, thanks to the Uninterruptible Power Supply (UPS)—a device that provides temporary power to connected equipment during outages or electrical disturbances—and a backup generator, radar operations were not affected. The faulty unit was promptly replaced with a spare, and no delay occurred in the procurement process.

<sup>19</sup> A circuit that protects the radar receiver from high-power transmission signals. It blocks strong transmitted signals and allows only weak received signals to pass through, thereby preventing damage to the equipment.

<sup>20</sup> A ventilation and air conditioning system primarily designed to cool radar equipment and related electronic devices.

The roles and contributions of the JICA Financial Cooperation Implementation Department and the JICA Pakistan Office in this Project are assessed as highly commendable overall. The JICA Pakistan Office provided effective support in banking procedures and the issuance of payment authorizations to ensure that payments to IMC and the contractors were made without delay, thereby facilitating smooth contract implementation and project progress.

In addition, during implementation, several monitoring visits were conducted in collaboration with missions from JICA Headquarters, through which an appropriate supervision framework was established to respond to the evolving project environment. Furthermore, the JICA Pakistan Office took the lead in coordinating with relevant authorities to secure frequency allocations and obtain the necessary No Objection Certificates (NOCs)<sup>22</sup> required for radar operations, providing both technical and institutional support to PMD. These efforts contributed to strengthening PMD's operational capacity.

Furthermore, consistent and effective communication between JICA and PMD was maintained throughout the project—via telephone, email, and face-to-face meetings. The trust established through their past cooperation contributed to smooth coordination and the stable implementation of the Project. Furthermore, JICA's accumulated experience in the meteorological and disaster risk reduction sectors formed an important foundation for this relationship, serving as a background factor that facilitated collaborative arrangements during the Project.

In light of the above, the contributions of JICA personnel, the appropriateness of the monitoring system, and the strong collaborative relationship with the implementing agency all functioned effectively, significantly contributing to the successful achievement of the Project's objectives.

- Additionality  
None

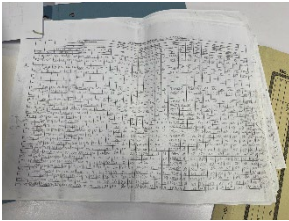


Photo 1: Inspection Record  
(Source: Taken by the Evaluator)

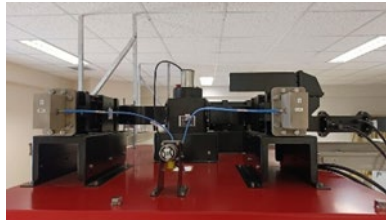


Photo 2: T/R Limiter  
(Source: Taken by the Evaluator)

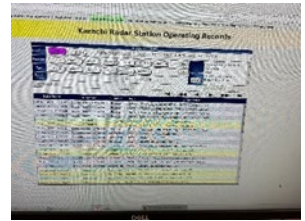


Photo 3: Error Message  
(Source: Taken by the Evaluator)

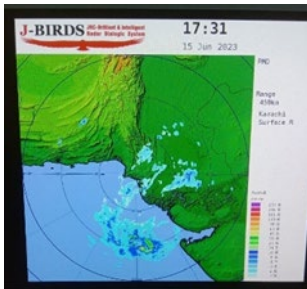


Photo 4: Meteorological Radar Image  
(Source: Taken by the Evaluator)

(end)

<sup>22</sup> An official letter of authorization issued by the Government of Pakistan, certifying that the government has no objection to the implementation of the project (or the installation of facilities/equipment). This document was required to be issued by the Pakistani side and obtained by the Japanese side as part of the Project implementation process.