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Annex 5

Lessons learned from implementing countries

Sentinel surveillance for PMM was piloted in four countries (Bangladesh, DRC, Haiti and Pakistan) over an 18 month period in 2020-2021. Three of the four countries completed the full pilot. At the end of the project the in-country team was requested to fill in the following lessons learned questionnaire covering the different phases of the work, as well as an overall assessment of success of the pilot.

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1. Project objectives and background

1.1 Was the sentinel system appropriate for your country and EPI programme? **YES**

COUNTRY 1	The Sentinel system received immediate support from the EPI programme as this “higher technical level” surveillance was seen as an opportunity to better track, monitor, and troubleshoot their CCE inventory. To be effective, the sentinel system relies on many contextual factors such as the ability to travel frequently (and safely) in the country, a minimum level of support from the National (central) Authorities as well as the local health center (HC) staff, a minimum level of adhesion to international standards such as the steady and appropriate use of temperature recorders. A reasonably functional public servant employment system is also necessary as the health facility workers (HFW) may or may not be in capacity to help regardless of their ability. The program in Country 1 was very challenging to implement as most of those conditions could not be met. The local health center workers (HCW) or technical staff often lack the necessary training and skills required to use digital tools to collect and transmit data to the sentinel officer, when/if they even have access to a computer. The State is very weak and poorly organized, resulting in very irregular and insufficient salary payments.

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	The payment of a small stipend (in the range of a few US dollars) to the HCW each month was often necessary to receive their support. In the case of storage facilities, the temperature recorders ("Fridge Tags") are often not assigned to a single unit. To avoid such issues, the recorder should be assigned a specific position in the fridge where it does not have to be removed in order to extract vials from the CCE (such as a fridge tag holder stuck to the inner wall, in the space between the basket and the wall for example). Alternatively, the temperature and remote monitoring tools provided by the CCE manufacturers and embedded in the units could also be PQS-approved.
COUNTRY 2	It was an appropriate system for the country as well as the EPI Programme.
COUNTRY 3	The sentinel system was appropriate for our country. Earlier the data regarding CCE and performance issues related to them was not being shared with the EPI and other stakeholders. However, during this project, our team made sure to identify breakdowns and report performance issues to concerned stakeholders in a timely manner for immediate corrective actions by manufacturers and EPI programmes.

1.2 Do you think another approach would have been more appropriate? Please share your insights and suggestions. MAYBE

COUNTRY 1	As the project's implementation has proven, the use of computer-based technology rapidly shows its limits, while mobile technology has proven to be far more reliable, accessible, and practical for most situations and people. It improved not only our ability to gather and aggregate the data, but also to analyze it. Typically, CCE do not fail instantly: the automated aggregation shows us patterns of slowly but consistently rising temperatures in a given unit, indicating a progressively failing cooling circuit prior to its actual failure and 30DTR alarm trigger threshold, thus allowing us to warn the facility and empty the fridge from its vaccine content prior to its failure.
COUNTRY 2	A modern version of FT device with provision of getting SMS alert from the FT device would be more appropriate. At present we can extract 60 days of data from the device we used, but the EPI Medical Technologists and Cold Chain Technicians do not receive any real-time alert from the FT device outside their routine working hours and weekends. As a result, when any alarm occurs from the FT device, they do not get that status until they get back to the office or

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	physically check in the morning and evening time during the office hours.
COUNTRY 3	The current approach was appropriate. However, one drawback of this system was that it relied heavily on the readiness, cooperation, and knowledge of the health facility staff of EPI centers. If for any reason the staff was not present during the surveillance time or there was a change in human resources, we tend to lose on the external factors that might have impacted the performance of cold chain equipment. The best way to fix this issue is to develop an electronic system where health facility staff is required to enter the data regarding all the external factors that may affect the performance of CCE.

1.3 Did the PMM Sentinel Surveillance pilot in your meet its objectives? **YES**

COUNTRY 1	Considering the results of our experience with the use of mobile and non-mobile technologies, along with the identification of actual, context-specific build issues with one of the most highly regarded equipment manufacturers in the industry and the design improvement it triggered on their part, added to the synergy it catalyzed between EPI staff and the manufacturer's representative, it is our belief that the pilot project yielded valuable insight and promoted improved CCE performance, and therefore met its objectives.
COUNTRY 2	The PMM Sentinel Surveillance pilot meets its objectives.
COUNTRY 3	Yes, the objectives of the PMM sentinel surveillance pilot were successfully met. The surveillance system helped us improve CCE performance through regular monitoring and reporting at selected EPI centers.

1.4 Would you recommend that Sentinel Surveillance continue in your and be expanded to other countries? **YES**

COUNTRY 1	The findings justify and support the continuation and fine tuning of the programme, as means to promote a better and more appropriate design, use and monitoring of the existing technology, better inform PQS specifications, as well as providing timely performance feedback to manufacturers and EPI divisions globally, thus moving us (collectively) closer to improved CCE performance. Further, we can only emphasize again the need, and advocate for the pertinence and validity of the CCIS tool.

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COUNTRY 2	The Sentinel Surveillance system is a feasible action for EPI programme with a potential to scale-up as a system strengthening approach for EPI programming.
COUNTRY 3	Our team does not only recommend the expansion of sentinel surveillance to other countries but the surveillance system should also be scaled up within the respective countries.

2. Setting up a Surveillance System

2.1 Describe the profiles of those involved in implementing the pilot.

COUNTRY 1	- Photovoltaic (PV) designer, installer, and electrician - Project Manager - The EPI and Ministry of Health staff included: - Director or DPEV (EPI) - Director of Logistics and Cold Chain at EPI Division - The five Regional Managers with their respective EPI cold chain technicians.
COUNTRY 2	This pilot was implemented jointly by in country implementer and EPI Programme with - One Sentinel Surveillance Officer (SSO), - One cold chain technician (CCT) and - One Surveillance Assistant (SA). The CCT and SA was mainly responsible for on-site problem identification and troubleshooting, collecting the data on CCIS and hard copy from the centers. The Sentinel Surveillance Officer on the other hand was mainly responsible for overlooking the data collection process, identifying problems and patterns within the data, recording daily field activities, coordinating the activities with the EPI Focal Point and other officials and updating the progress to WHO
COUNTRY 3	The implementation team of the project consisted of - Cold Chain Technician (CCT), - Research Associate (RA), and - a manager.

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	CCT was hired with an educational background in cold chain engineering and equipment maintenance and was responsible for making monthly visits to sentinel sites. The RA had to ensure that the CCT makes in-person monthly visits to all the selected centers either by personally making surprise field visits or through GSM tracking. He was responsible for directly managing CCT and making sure all the required documents and pictures are sent to the management team in a timely manner and CCIS forms are correctly filled and uploaded immediately after the field visits. Furthermore, he prepared daily progress reports. RA also conducted preliminary data analysis and made weekly reports. RA directly reported to the manager, the person in charge of the CCM project from initiation to close. The manager had to make sure all the project activities are being completed on time and efficiently. The role included planning the project process, budget management, assuring all the deliverables are met, managing the team, and communicating with stakeholders. Monthly progress was shared with the respective stakeholders by the manager.

2.2 How were the sites selected? What was the involvement of EPI in the selection?

COUNTRY 1	A list of criteria was established jointly between WHO-PQS, and implementer. This was then presented to the EPI Division and partners who jointly established a preliminary short list of approximately 20 sites representing 44 CCE. Based on transportation times, costs and other logistics factors, that short list was refined with EPI to 10 sites and 42 units.
COUNTRY 2	The sentinel sites were selected based on discission with the Cold Chain Engineer of EPI & Surveillance and other team members at EPI Head Office. At the beginning a baseline assessment was conducted in a few sentinel sites to understand the current status of the cold chain system in those locations. EPI Head Office supported the baseline data collection by issuing a support letter to the Health Managers of the selected study sites for providing necessary support to the project team. 20 sites were finally selected for the piloting.
COUNTRY 3	Sites were selected in consultation with EPI and WHO, on the basis of Health Facility Assessment (HFA) data, and existing inventory,

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	deployment, and installation data. The sentinel sites were selected on the basis of a number of factors including; • A wide range of cold-chain equipment manufacturers • CCEOP and non-CCEOP equipment • Easy to reach and hard to reach areas • High and low performing areas • Urban and rural areas

2.2.1 Was there an existing inventory used in the selection process? Where there any challenges? **YES**

COUNTRY 1	It did take a long time (months) to establish the final site list, but mostly due to the contextual challenges at the time, e .g. civil unrest and the pandemic.
COUNTRY 2	Implementer conducted a baseline survey to collect information on the existing inventory of CCE at the selected centers.
COUNTRY 3	A baseline survey was conducted to collect information on the existing inventory of ILRs at the selected centers. As per the inventory list provided by the EPI, there were 220 CCE at the selected centers. However, 46 CCE were not found during the baseline survey.

2.2.2 Please share your recommendations on how to change, improve or make this step more efficient

COUNTRY 1	The process was conducted appropriately and to the satisfaction of all involved parties
COUNTRY 2	- Allocating more FT devices to maintain sentinel surveillance. - Making inventory up-to-date for documentation. - Coordination and consultation meeting with civil surgeon office, UHC and EPI for selecting a low performance site.
COUNTRY 3	To make this system more efficient electronic database is required which needs to be updated regularly. The initial inventory list that was shared by EPI was not coherent with the inventory physically present at the facilities. It was better to conduct the surveillance and rely on the inventory physically present at the health facilities than waiting for the EPI to share the list with us which was not updated.

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2.3 What was the process of setting up the reporting from the sites? Was each site visited? Was the inventory updated? Was there training? What was the role of local EPI?

COUNTRY 1	It was nearly impossible to gather the data remotely, due to technical and HFW training reasons. We rapidly sought to visit each site every month. Whenever there were issues with a CCE on a given site, the information was immediately transmitted to us (by phone), as well as the EPI Management, who in turn could trigger maintenance procedures and maintain its own inventory up-to-date.
COUNTRY 2	Local EPI personnel (MTEPI and CCT) play a role in addition to our project CCT and Surveillance Assistant. Our project workers collect data from UHC and the civil surgeon office. At the UHC and Civil Surgeon offices they read FT devices through their office equipment. Most of them do not have computers. So, they read FT data through its screen showing 30 days data along with alarms and other problems. When we go for data collection, they help us and subsequently we update the inventory data for future use and documentation.
COUNTRY 3	Cold Chain Technician (CCT) conducted monthly visits to each sentinel site to collect performance data. During the inspection of cold chain equipment if our technician noticed that any of the alarms were present due to negligence or improper knowledge of health staff or vaccinators then the CCT used to conduct on-ground training to build capacity among the local EPI staff.

2.3.1 How were staff at sentinel sites trained on use of the data collection tool?

COUNTRY 1	They received hands-on experience through in person training in the facilities on the use of a computer with the temperature recorders and on how to retrieve the data log from the fridge tag into the computer so they can send it to us by email. Our monthly visits were also an opportunity, in the case of failures, to review troubleshooting and failure identification methods on both the electrical and cooling components of the fridges. Further, the Root Cause Failure Analysis introduced the notion of verifying certain specific mechanical parts of the units, such as door hinges, which was a plus. However, most technicians proved to be uncomfortable with a form of technical use of computers (unlike phones), and our efforts remained largely unrewarded on that aspect.

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COUNTRY 2	The staff at sentinel sites attended a daylong workshop at EPI headquarters about the pilot project, data collection tool, and other technical issues focusing on - management of ILRs and vaccine storage, importance of Cold Chain Equipment Monitoring mechanism, temperature monitoring and significance of temperature alarms, ILR repair and maintenance, and vaccine safety, standard operating procedure in case of ILR failure. The Cold Chain Engineer of EPI & Surveillance and two other EPI Medical Officers acted as the facilitators.
COUNTRY 3	Data collection on CCIS was done purely by the implementer. However, during the pandemic, our team could not visit the out-station sites so our technician conducted surveillance via phone calls. During that time staff present at sentinel sites was trained to do the detailed inspection of cold chain monitoring equipment.

2.3.2 Did you prepare training materials? **YES**

COUNTRY 3	A training document was prepared to equip the EPI staff present in targeted sites with the relevant concepts, tools, and techniques in particular the protocol to be followed for the failure of CCE.

2.3.3 Were there any challenges? If so how were they addressed?

COUNTRY 1	The use of a mobile-based solution, connecting through a cable or better, wirelessly, to the temperature recorder, would have improved the implementation.
COUNTRY 2	Although we obtained a support letter from the Line Director, MNC&AH DGHS for data collection, without a civil surgeon letter no center allowed us to collect data. We then obtained permission from the civil surgeons of selected districts as well, that enabled us to start data collection. We faced a challenge in training implementation. The technicians and vaccinators were so busy with activities related to the MR campaign and routine immunization works, it was difficult to bring them to EPI headquarters for the training. Finally, based on consultation with the EPI HQ we started providing on-job training during the site visits by the Surveillance Officer and Project Technician and then organized a follow-up training at EPI HQ. Following training, health workers actively involved with the project actions and started providing feedback on CCE and vaccine delivery and the temperature sheets were maintained and updated on a regular basis by the health workers.

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2.3.4 Please share your recommendations on how to change, improve or make this step more efficient.

COUNTRY 1	We strongly advocate for the use of a mobile-based application such as VARO or the CCIS tool.
COUNTRY 2	● Developing a capacity development plan and providing need-based training ● Instituting a process ongoing capacity development through on-job training ● Develop specific SOPs for EPI staff for properly operating ILR with FT devices ● Use of PMM taxonomy for making SOP and training materials. ● Increase communication and coordination
COUNTRY 3	To make this step more efficient a training manual has to be developed for the users of CCIS and we could also use a two-way interactive training method where we can start the training with some sort of game or quiz to figure out the existing knowledge of the vaccinators and health staff involved with the handling of vaccines. This would also help trainers in conducting training in the most efficient manner.

2.4 Please describe the key cost drivers in the budget.

COUNTRY 1	In the context of this specific country, a critical part of the budget is the cost of transportation, lodging and meals.
COUNTRY 2	The key cost divers were: the personnel expenses; travel and field expenses; logistics supplies and equipment; and trainings, meetings/workshops
COUNTRY 3	The main cost was developing the CCIS form for data collection and the human resource cost involved in the project. Other costs included travel expenses within and outside the city and the cost of internet dongle devices that were used in low internet connectivity areas.

2.4.1 Did implementation follow the original workplan or did you need to make changes along the way? Please describe the changes and the reasons for the changes. What was the impact of the changes?

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COUNTRY 3	COVID 19 lockdown had restricted the mobility of our field team. Hence, in order to avoid hindrance in field activity, CCT gathered information from centers through phone calls and requested vaccinators to send pictures for record-keeping.

2.5 How did the project establish the roles and responsibilities of stakeholders from the health facility through to regional/national EPI? Was an agreement (or MOU) established with the national authorities?

COUNTRY 1	Terms of collaboration were discussed between SO and EPI Director, leading to an agreement listing roles and responsibilities of all stakeholders.
COUNTRY 3	We did not establish an MoU with the national authorities. However, we were able to obtain a letter of support from EPI as a result of which we were allowed to conduct surveillance at sentinel sites without any issues. EPI's role in this project was to provide support in data collection by ensuring all the necessary permissions are given to the project team and the health staffer able to provide relevant information without any hesitation.

2.5.1 Were there any challenges? If so how were they addressed?

COUNTRY 2	Baseline data revealed that fridge tags were not available in all ILRs where the temperature was recorded. We discussed this with the EPI focal person and ensured fridge tags for the identified locations.
COUNTRY 3	Due to a lack of communication between EPI and the facilities we faced some trouble during our first monthly visit to the sentinel sites as the staff available at the centers was not informed ahead of our activity. To address this, we had to involve our liaising team who contacted district health management and gave them the overview and purpose of our monthly visits. During the course of the project, the team also faced issues regarding timely corrective action from the national authorities in respect to the reported non-functional ILRs. To address this our team constantly followed up with the concerned personnel and monthly reports were also sent to EPI officials.

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2.5.2 Please share your recommendations on how to change, improve or make this step more efficient

COUNTRY 2	Health centre staff need training on CCE. Need to increase human resource in terms of workload in UHC and civil surgeon office to overcome the problem of the ILR. This is because if they are overburdened with work, they don't pay proper attention to maintain ILR as well as vaccine potency. A robust mechanism is needed for maintaining a sentinel surveillance system.
COUNTRY 3	An integral part to make this step more efficient is for organizations to have a strong and healthy relationship with local authorities. Furthermore, pre-defined roles and responsibilities or expectations from local authorities as well as project teams would be beneficial for the implementation of the project.

3. Managing Routine Surveillance

3.1 How was monthly reporting done (ie email, paper, WhatsApp, CCIS, other)?

COUNTRY 1	Through in person visits, the use of the VARO app, WhatsApp (particularly with the local staff) and manual excel recording. In terms of reporting, it was not possible to obtain anything more than a phone call from the sites.
COUNTRY 2	During the project period, data was collected by respective HCWs/technicians on a paper-based format and then compiled into an Excel sheet. The cold-chain technician also collected the Fridge Tag (FT) reports in PDF format in his cell phone.
COUNTRY 3	Monthly reporting from sites was done through CCIS but daily field and progress reports were also prepared to cross-check the CCIS data. At the end of the month, data from all the health facilities was consolidated and presented in form of tables and graphs through slides on PowerPoint.

3.1.1 Were there any issues with correctness, completeness or timeliness of reporting?

COUNTRY 1	Among the main issues we noted: the difficulties in reaching sites leading to irregular data access, the swapping of FTs among refrigerators within a given site, regularly failed FTs, frequently improperly commissioned Fridge Tags (wrong startup date, wrong metric system), inability of the local HCW (from skill or access to tools) to transmit us the data remotely, absence of fridge tag occasionally leading to daily manual readings from the local HCW.

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3.1.2 Were there any challenges? If so how were they addressed?

COUNTRY 2	We used WhatsApp, IMO, Messenger etc. platforms as the main tool of communication - sharing of the picture of CCE, temperature sheets etc. happened regularly between the field staff and SA/CCT.
COUNTRY 3	The main challenge faced was the internet connectivity issues especially in rural areas. To address this, we provided an internet device to our CCT however, there were still areas where the device would not work and, in that case, the CCT was required to fill the form offline and submit it once he is in the range of internet connectivity.

3.1.3 Please share your recommendations on how to change, improve or make this step more efficient.

COUNTRY 2	To ensure immediate reporting of any errors to CCT and subsequently to EPI focal person for taking resolving initiatives, use of modern FT devices with provision SMS alert system direct to the mobile phones of the appropriate persons in case of any errors might help taking prompt actions to resolve those errors.
COUNTRY 3	EPI personnel should have been more involved in the implementation of the project as they are more aware of the locations of the facility centers in rural and hard to access areas. At least during the first visit, an EPI staff member should have accompanied our team for a brief introduction and to avoid any sort of reluctance from the health facility staff.

3.2 What did a routine visit entail? Did you use a checklist?

COUNTRY 1	Overall visual check of the units, their position, their mechanical parts, their displays, followed by standard pictures: unit's front, inside, back with sticker, along with standard routine questions/check-ups. Whenever an issue was found, we looked into more closely, opened the back of the unit to check the cooling and electronic circuits, performed electrical verifications, trying to identify the source of the problem.

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3.2.1 Were there any challenges? If so how were they addressed?

COUNTRY 2	Engaging EPI technicians and securing full support from them was challenging, as they were very busy with activities related to routine immunization. They had limited knowledge about the technical issues of the fridge and were able to fix only the minor problems. There is a critical need for more CCTs.
COUNTRY 3	A challenge that was faced during the first few monthly visits was that the staff available at the health facilities were not aware of the surveillance project our team was undergoing. They would not allow us to access the CCE data just on the basis of the letter of support issued by the EPI. This resulted in delays as we had to connect the health facility in charge with the EPI authorities.

3.3 Did an EPI CCE Technician accompany the SO to the site visits? Did EPI finance the CCE Technician or did the project have to pay per diem? Please describe. What were the barriers (if any) to the engagement of EPI CCE Technician? **YES/NO**

COUNTRY 1	During most of our visits, the Regional EPI CCE Technician was present. At larger sites, so was the local Technician. We did pay the Regional (and/or local) EPI CCE Technician per diem without which their support could not have been obtained (see previous sections).
COUNTRY 3	No, the EPI technician did not accompany the CCT to the sites due to unavailability, and furthermore, EPI was not very comfortable in sending their technician on surveillance visits as they felt it was not part of their technician's Job Description. Furthermore, EPI did not finance any part of the project and implementer needed to pay per diem to technicians and the management team in case of any visits.

3.3.1 What were the key barriers to the engagement of EPI Cold Chain Engineer and CCE Technicians?

COUNTRY 2	Lack of appropriately trained CCE Technicians. Routine immunization work and campaign work load. Knowledge gaps and lack of capacity building initiatives on the cold chain system.

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3.4 Failure analysis visits: Were there any challenges? If so how were they addressed?

3.1.1

COUNTRY 1	While some failures can be identified while a CCE is off (damage, visible points of corrosion/chemical burns, etc.), many others may require the availability of spare parts to test and fix certain elements of the fridge such as electronic control boards, or a compressor, or simply refrigerant gas. Unfortunately, the availability of such spare parts was a difficulty throughout the project.
COUNTRY 3	Yes, the main challenge faced was when no visible issue was detected in the CCE, and the cause of alarms could be any external factors. The occurrence of external factors can only be known to health facility staff members who keep on rotating and may or may not be present during the time of our monthly visit. To address this issue our CCT had developed good relations with health facility staff members who gave their contact numbers to CCT in case he had any queries. Another challenge faced was the difference in definitions used by national authorities and WHO. National authorities considered all those CCE non-functional that were not operational while WHO's definition of non-functional ILR was based on the number of alarms that occurred during one month. To address this, we conducted in-person meetings with the EPI officials..

3.4.1Please share your recommendations on how to change, improve or make this step more efficient

COUNTRY 1	Always include substantial amounts of spares associated with a units' procurement (they are surprisingly cheap and most of them can be stored for years).
COUNTRY 2	The EPI should consider all three categories of failure analysis for any non-functional ILRs, i.e. equipment performance, programmatic issue, and external factors. Instead of referring to "human error" the "programmatic issue" should be carefully analyzed.
COUNTRY 3	One recommendation is that the details of all the external factors like power outages etc. should be recorded to avoid confusion for anyone surveilling the CCE. Another recommendation is that the concerned EPI officials should have been involved in the project from the start of the project and all the definitions should have been shared with them initially for clarity.

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3.5 How often did you report back to the national authorities and WHO? What format did the reporting take?

COUNTRY 1	We did report on a quarterly basis to WHO, and these reports were translated into French and sent to EPI management. When not possible, they were sent the English version
COUNTRY 2	The project reported the progress and challenges to national authority and WHO on a monthly basis.

3.51 Please share your recommendations on how to change, improve or make this step more efficient.

COUNTRY 1	The availability of the aggregated data online, along with reported failures and associated diagnostics, would considerably simplify communication and lead to improved collaboration and overall CCE management.
COUNTRY 2	● EPI HQ should devise strategies to promote project tools including CCIS for real-time data collection and reporting for EPI personnel. ● EPI should consider hosting data through CCIS internally into DGHS MIS server. ● Training should be arranged for respective staff on CCIS use for real-time data collection and future reporting. ● Provision of updating inventory in the CCIS application to accommodate any changes in inventory requirement of EPI.
COUNTRY 3	To improve ownership within the national authorities they should have been kept in the loop since the start of the project and, rather than just having support from them, we should have requested active participation. Furthermore, monthly review meetings should be kept with EPI officials and discussion of cold chain management should be part of meetings with the Health Minister.