OPERATION AND MAINTENANCE OVERVIEW FOR PROGRAM PENGEMBANGAN KECAMATAN (PPK) AND PROGRAM NASIONAL PEMBERDAYAAN MASYARAKAT (PNPM)

To Assess the Operation and Maintenance of PPK and PNPM Implemented Micro-Infrastructure Projects in Indonesia between 1999 and 2007

Monday, 29 June 2009

Prepared for:
Mr. Victor Bottini
PNPM Team Leader
World Bank – Jakarta
Jl. Diponegoro No.8
Jakarta 10310
Indonesia

Prepared by:
Mr. Ted E. Kulongoski, E.I.T.
Kupang, West Timor (N.T.T.)
Indonesia
Email: tekulongoski@hotmail.com

EXECUTIVE SUMMARY

This report is based solely on Program Pengembangan Kecamatan (PPK) and Program Nasional Pemberdayaan Masyarakat (PNPM) monitoring missions conducted between November 2006 and December 2008 in 12 Provinces of Indonesia. The objective is to assess the continued functioning status of micro-infrastructure projects implemented through the PPK/PNPM program between 1999 and 2007 (a nine year period).

As part of the monitoring process, PPK/PNPM micro-infrastructure projects were examined for continuing operation and maintenance performed by the beneficiary communities. From observations and interviews compiled during each site visit, micro-infrastructure projects were ranked based on a three-tier system using the following scale:

- Fully Functioning = Infrastructure is operating as intended, 100 percent of the time;
- Partially Functioning = Infrastructure is operating at a lower level than intended and/or operating only part of the time, and
- Not Functioning = Infrastructure is not operating at all.

Micro-infrastructure projects constructed with PPK/PNPM funding often include multiple structures (e.g., twenty toilets) distributed throughout a local area. Therefore, during each site visit, it was often necessary to select between two to five units to be used as a sample to determine the operation and maintenance ranking for a specific project. Also, when assessing project operation and maintenance, it is assumed that each infrastructure project was designed and constructed so that when finished, the infrastructure would be ranked as Fully Functioning. It is important to note though, that due to variance in program application, available materials and skill levels within each community, project design and "as-built" construction varies widely between villages, districts, and regencies, which ultimately impacts the initial design and construction quality of the final project.

A total of 16 monitoring missions were completed by the author, which reviewed a total of 657 PPK/PNPM micro-infrastructure projects built between 1999 and 2007. From this total sample size, 470 projects were assessed to still be Fully Functioning (72%), 139 projects were assessed to be Partially Functioning (21%), and 48 projects were assessed to be Not Functioning (7%). From the overall total of 48 Not Functioning projects (Table 5), 14 projects (29%) are Not Functioning because of a broken pump, motor and/or generator. These projects represent just over two percent of all projects reviewed for this report and were most often reported broken due to the substandard quality of the mechanical equipment

When the same project data set of 657 projects was divided into five yearly sub-sets, it was observed that looking backwards in time from year 2007, there was a decrease each year in the percent of Fully Functioning projects in the first three years (2007, 2006 and 2005). In year 2004 the percent of Fully Functioning projects leveled off and was approximately the same as in year 2005. The decrease noted above in the percent of Fully Function projects would indicate that over time, some projects that were once Fully Functioning, later become Partially Functioning or Not Functioning.

Causes for increases in Not Functioning projects were compiled using the data from the 657 projects identified earlier. A variety of causes were found to be project related (i.e., design, construction or maintenance issues), other causes were socio-economic in nature, and a few problems were caused by accidents or hazards. From these three casual groups a list of ten recommendations were derived to:

Reduce Mechanized Equipment Operation and Maintenance Issues:

1. Identify high quality makes and models of commonly purchased project equipment (i.e., pumps, motors, generators, turbines and boat motors) and determine how best this equipment can be ordered, purchased and delivered to project work sites (this has already been done to some extent for micro-hydro turbines).
2. Explore alternative energy devices (solar, wind, water and biogas) that can provide the same performance level as fossil fuel consuming equipment but that do not require the same continued economic inputs needed to purchase fuel.
3. Provide system operator(s) with specialized technical training on operation, maintenance and repair to mechanized equipment.

Maintain the Number of Fully Functioning PNPM Projects Over Time:

4. Coordinate with Government of Indonesia and other external organizations to prevent redundant projects.
5. Assess whether the community is capable of generating the needed funds to maintain, repair and replace project component(s).
6. Ensure the highest quality of initial project design work is completed for each project and assure community members follow final project design.
7. Ensure the highest project construction quality, including preventing the use of inferior or unsuitable materials.
8. Ensure that the community's promised contribution to the project is realized.
9. Provide continued supervision and motivation during project implementation to assure full completion of project works by the end of the funding cycle.
10. Work with community members to plan for and organize regular maintenance to assure the project remains fully functioning.

An additional analysis was completed in order to determine the affect, if any, that initial design and construction quality had on project operation and maintenance performance from 1999 to 2007 (a nine year period). Results indicated that as the initial design and construction quality of a project decreases (from Sufficient to Nearly Sufficient to Insufficient), so to does the observed number of Fully Functioning projects. This correlation suggests that the better a project is initially designed and constructed, the more likely it will remain Fully Functioning over time. These results were assimilated into the list of recommendations.

INTRODUCTION

The information presented by the author in this report is based solely on Program Pengembangan Kecamatan (PPK) and Program Nasional Pemberdayaan Masyarakat (PNPM) monitoring missions conducted between November 2006 and December 2008 in 12 Provinces of Indonesia. The information presented hereafter is based on the technical critiques of completed micro-infrastructure projects implemented as part of the PPK/PNPM program. Projects are identified as "micro-infrastructure" because they are designed and constructed for regular and continuous use, they are located in the vicinity where community members live and work and they have an implementation budget of less than USD 40,000.

As part of the monitoring process, PPK/PNPM micro-infrastructure projects were examined for continuing operation and maintenance performed by the beneficiary communities. Using the model developed by the PNPM Directorate General for Community and Village Empowerment, Ministry of Home Affairs, ranking of micro-infrastructure projects is based on observations and interviews compiled at the time of the site visit. Ranking follows a three-tier system, which uses the following scale:

FULLY FUNCTIONING = Infrastructure is operating as intended, 100 percent of the time.
Examples:

- Rainwater storage reservoir is intact, connected to roof gutter system, with all faucets and piping intact (Appendix A).
- Culvert has no cracks, has graded approaches and has no vegetation or debris blocking entrance/exit (Appendix A).
- Building (i.e., school or clinic) is used regularly by community, is structurally intact and complete and can be locked and secured (Appendix A).

PARTIALLY FUNCTIONING = Infrastructure is operating at a lower level than intended and/or operating only part of the time.
Examples:

- A hand-dug well is missing its pulley, which results in water being drawn from the well using contaminated buckets (Appendix B).
- Cement slab walkway surface is deteriorating and breaking apart forming holes making passage problematic (Appendix B).
- Boat dock provides boat mooring only at high tide because the boat dock is not long enough to reach deep water at low tide (Appendix B).
- Dirt road has uncut vegetation growing on travel surface and along shoulders (Appendix B).

NOT FUNCTIONING = Infrastructure is not operating at all.
Examples:

- Electric generator motor is broken so no electricity can be produced (Appendix C).
- Village toilet is not used because septic tank is full (Appendix C).

Micro-infrastructure projects constructed with PPK/PNPM funding often include multiple structures (e.g., twenty toilets) distributed throughout a local area. Therefore, during a site visit, due to the often large number of structures and the great distance between structure locations, it is necessary to select between two to five units to be used as a sample to determine the operation and maintenance ranking for a specific project. Also, if at the time of the site visit, a reviewed project is still in the construction phase for the current funding cycle, the project does not receive an operation and maintenance ranking, as it is not possible to determine the functioning status of an unfinished project. On the other hand, if during a site visit an unfinished project from an earlier funding cycle is reviewed, the project is considered incomplete and is still given an operation and maintenance ranking,

ASSUMPTION

There is no established baseline from which to accurately assess the operation and maintenance over time of the entire set of micro-infrastructure projects considered for this report. Therefore, the assumption for assessing operation and maintenance is that each infrastructure project was designed and constructed to operate optimally as soon as construction was completed. It is important to note though, that due to variance in program application, available materials and skill levels within each community, project design and "as-built" construction can vary widely between villages, districts, and regencies, which ultimately impacts the initial design and construction quality of the final project. Later in this report, this assumption is analyzed to determine the affect, if any, that initial project design and construction quality have on operation and maintenance performance over time.

OBJECTIVE

The objective is to assess the functioning status of micro-infrastructure projects implemented through the PPK/PNPM program between 1999 and 2007 (a nine year period). The current functioning status of projects is assessed during site visits and establishes, in many cases, the quality and quantity of operation and maintenance preformed by the beneficiary community over time. As observations alone are not absolutely accurate, it is also necessary to carry out interviews with community members to acquire additional information for understanding the current functioning status of a project. Through statistical analysis, the data collected from these two sources provides results, which are compiled and used to provide the framework from which to make recommendations on what is needed to increase project sustainability.

METHOD

Data used in this report was compiled from 16 mission summary reports completed for the World Bank Office – Jakarta between November 2006 and December 2008. A Province-by-Province summary of the 16 mission trips is presented in Table 1.

Table 1: Summary of World Bank trips completed for PPK/PNPM micro-infrastructure project monitoring from 2006 to 2008 in Indonesia.

Provinces Visited	No. of Visits	No. of Kecamatans/ Districts Visited	No. of Villages Visited	No. of Projects Reviewed
1. Gorontalo	1	12	27	69
2. Maluku	1	5	21	33
3. Maluku Utara	2	14	58	113
4. Nusa Tenggara Timur	2	9	11	12
5. Papua	2	13	40	114
6. Papua Barat	3	14	87	170
7. Riau	1	7	10	13
8. Sulawesi Barat	1	5	15	19
9. Sulawesi Selatan	1	8	31	48
10. Sulawesi Tengah	1	4	17	23
11. Sulawesi Tenggara	2	11	32	44
12. Sulawesi Utara	1	8	23	46
Total:	**18**	**110**	**372**	**704**

PPK/PNPM monitoring missions reviewed a total of 704 micro-infrastructure projects in 372 villages (each village site visit reviewed from one to seven projects). The 704 micro-infrastructure projects reviewed can be grouped into 18 different project categories to provide a province-by-province distribution of project types reviewed (Table 2). The three most frequently observed PPK/PNPM projects are buildings, toilets and roads. The four least often observed PPK/PNPM projects are washing facilities, wood boardwalks, micro-hydro turbines and irrigation projects.

Table 2: Distribution of PPK/PNPM projects reviewed based on distribution frequency of project type and contributing Province.

PPK/PNPM Micro-Infrastructure Projects by Province	Gorontalo	Maluku	Maluku Utara	Nusa Tenggara Timur	Papua	Papua Barat	Riau	Sulawesi Barat	Sulawesi Selatan	Sulawesi Tengah	Sulawesi Tenggara	Sulawesi Utara	Total by Project
Buildings	10	7	19	1	11	28	6	5	12	4	15	12	**130**
Toilets	20	3	13	1	8	20	0	2	5	3	3	7	**85**
Roads	7	2	6	2	18	9	3	1	4	8	7	5	**72**
Gravity Water Systems	2	6	5	6	5	22	0	3	5	4	3	7	**68**
Bridges	5	1	3	2	15	16	3	4	6	0	2	3	**60**
Cement Walkways/Stairs	1	2	14	0	2	24	0	0	0	0	4	3	**50**
Wells	15	2	1	0	19	9	0	0	0	0	2	2	**50**
Drainage Ditches	1	1	14	0	2	5	0	0	2	0	2	6	**33**
Pumped Water Systems	1	3	7	0	7	9	0	0	4	0	1	0	**32**
Culverts	1	1	2	0	12	9	1	1	2	0	0	1	**30**
Docks and Piers	0	1	8	0	4	5	0	0	1	0	2	0	**21**
Engine/Generator Electricity	2	0	5	0	5	7	0	0	1	0	1	0	**21**
Sea Walls	0	2	11	0	1	2	0	0	0	1	2	0	**19**
Retaining Walls	2	2	2	0	0	1	0	0	2	2	0	0	**11**
Irrigation	1	0	0	0	0	0	0	1	1	1	0	0	**4**
Micro-Hydro Electricity	0	0	0	0	0	0	0	2	2	0	0	0	**4**
Wood Boardwalks	0	0	2	0	2	0	0	0	0	0	0	0	**4**
Washing Facilities	0	0	1	0	0	0	0	0	0	0	0	0	**1**
Miscellaneous	1	0	0	0	3	4	0	0	1	0	0	0	**9**
Province Totals:	**69**	**33**	**113**	**12**	**114**	**170**	**13**	**19**	**48**	**23**	**44**	**46**	**704**

A total of 704 projects were reviewed in 372 villages in 110 Kecamatans in 12 Provinces across Indonesia. Unfortunately, all 704 of these projects could not be included for analysis in this report due to on-going construction of some projects at the time of the site visit. As a result, 47 projects were excluded, which reduced the total sample size to 657 projects. Since the focus of this report is on the operation and maintenance of PPK/PNPM projects from 1999 to 2007, it was necessary to create project sub-sets grouped by the year a project was funded (Table 3). The creation of yearly sub-sets allows for analysis of the data over time.

Table 3: Number of PPK/PNPM micro-infrastructure projects reviewed per funding year and the number of contributing provinces.

Year Project Funded	Total Projects Review	Unfinished Projects to Exclude	Total Projects Included in O&M Data Set	No. of Provinces Contributing to Data Set
1999	5	0	5	1
2000	2	0	2	2
2001	10	0	10	4
2002	3	0	3	1
2003	13	0	13	6
2004	88	0	88	10
2005	146	0	146	11
2006	262	1	261	11
2007	171	42	129	10
2008	4	4	0	1
Total:	**704**	**47**	**657**	**(a)**

(a) 12 provinces were visited to collect project data – many provinces provided data for multiple years

The sample size for each of the years 1999, 2000, 2001, 2002 and 2003 are too small to be considered as discrete sub-sets, whereas the sample size for years 2004, 2005, 2006 and 2007 are each large enough to be discrete sub-sets. To create the sub-sets needed for analysis, all the project data for years 1999 to 2003 was combined to create a sub-set with 33 projects from 9 different provinces (Table 4).

Table 4: Project data sets arranged chronologically and with corresponding sample size.

	1999-2003	2004	2005	2006	2007	Total
Total No. of Projects Included in Data Set	33	88	146	261	129	**657**

This arrangement created a total of five sub-sets from which to analyze operation and maintenance of PPK/PNPM micro-infrastructure projects over time.

RESULTS

Within the five sub-sets, all the projects funded for that time period were grouped and arranged according to their operation and maintenance ranking of Fully Functioning, Partially Functioning and Not Functioning (Table 5).

Table 5: Distribution of project operation and maintenance ranking over time.

RANKING	1999-2003	2004	2005	2006	2007	Total
Fully Functioning	26	54	87	198	105	**470**
Partially Functioning	6	26	40	45	22	**139**
Not Functioning	1	8	19	18	2	**48**
Total:	**33**	**88**	**146**	**261**	**129**	**657**

Because the sample size (total projects) for each of the yearly sub-sets varies, it is difficult to interpret the results in Table 5. Instead, if the results in each sub-set in Table 5 are converted to percentages based on each sub-set total sample size, the results are more easily compared (Table 6).

Table 6: Percent distribution of project operation and maintenance ranking over time.

RANKING	1999-2003	2004	2005	2006	2007	Overall
Fully Functioning	79%	61%	60%	76%	81%	**72%**
Partially Functioning	18%	30%	27%	17%	17%	**21%**
Not Functioning	3%	9%	13%	7%	2%	**7%**
Total:	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

The results in Table 6 indicate that the greatest numbers of Fully Functioning projects (81%) are those that have been most recently built in 2007. The lowest numbers of Fully Functioning projects (60%) are in year 2005. The greatest numbers of Partially Functioning projects (30%) are in year 2004. The lowest numbers of Partially Functioning projects (17%) are in years 2006 and 2007. The greatest numbers of Not Functioning projects (13%) are in year 2005. The lowest numbers of Not Functioning projects (2%) are those that have been most recently built in 2007 (Figure 1).

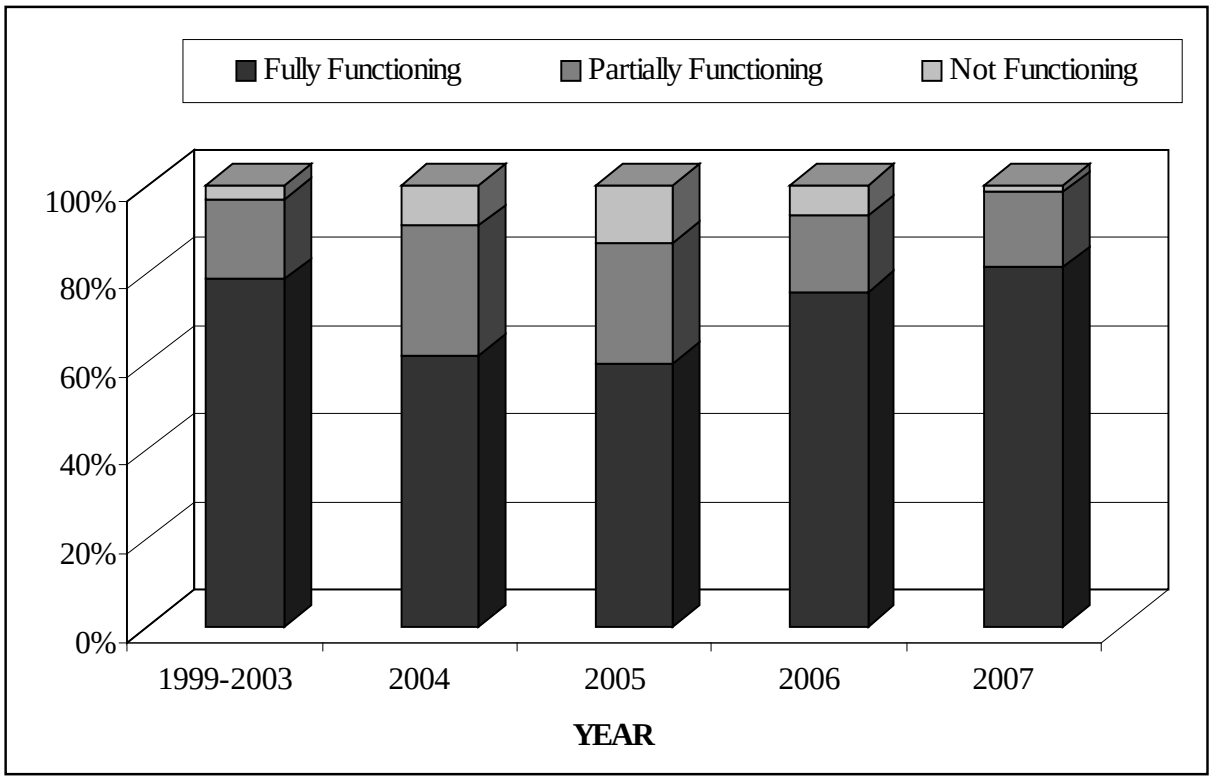

Figure 1: Percent of projects with operation and maintenance ranking found to be Fully Functioning, Partially Functioning and Not Functioning per year grouping.

When all project sub-sets are analyzed as a single sample, the overall results indicate that of all the completed PPK/PNPM micro-infrastructure projects reviewed for this report:

- 72% are Fully Functioning;
- 21 % are Partially Functioning; and
- 7 % are Not Functioning (Figure 2).

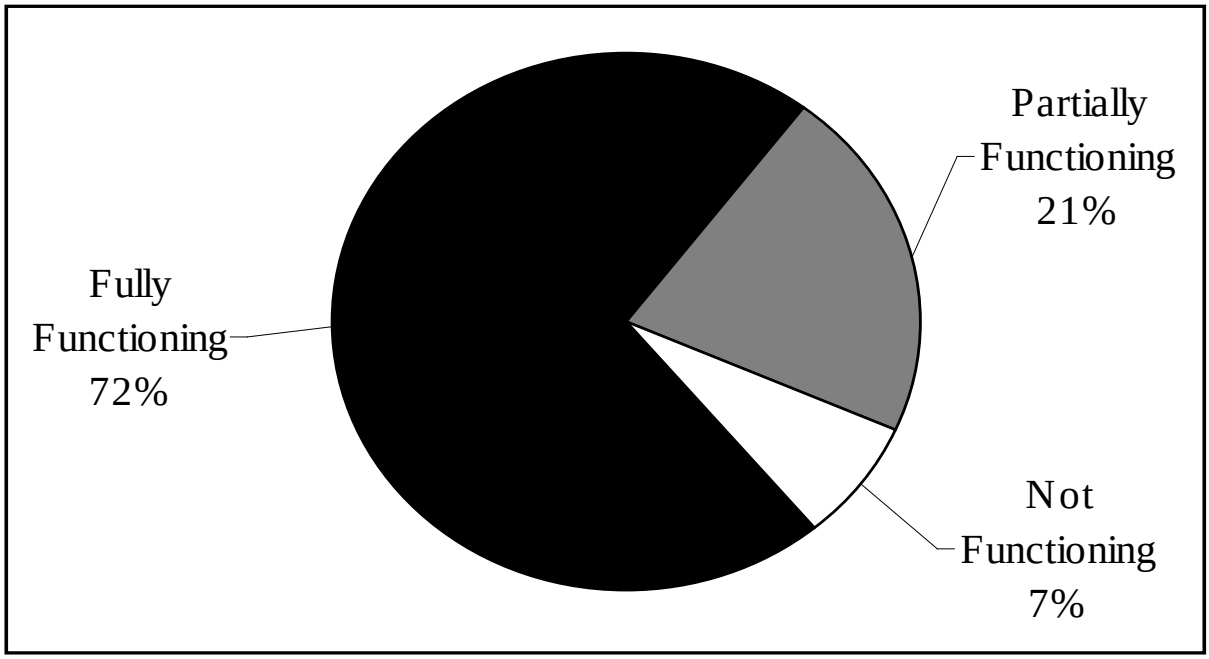

Figure 2: Overall operation and maintenance ranking for all reviewed projects from 1999 to 2008.

As established in the Assumption section, the ranking of project operation and maintenance was completed assuming that micro-infrastructure projects were initially designed and constructed to be fully functioning upon completion. However, as was evident by the variation in project design and "as-built" construction observed during each site visit, the quality of final project output varied between villages, districts and regencies. Therefore, additional analysis was completed to assess how variations in initial project design and construction quality might impact the operation and maintenance of projects over time.

The entire data set of 657 projects was used for this analysis resulting in a total of four Design & Construction groupings. The first grouping included all projects with both Sufficient design and Sufficient construction scores (Sufficient | Sufficient). The second grouping included all projects with Sufficient design and Nearly Sufficient construction scores or Nearly Sufficient design and Sufficient Construction scores (Sufficient | Nearly Sufficient). The third grouping included all projects with Nearly Sufficient design and Nearly Sufficient construction scores (Nearly Sufficient | Nearly Sufficient). The last grouping included all projects with an Insufficient design and/or Insufficient construction score (Insufficient | Insufficient). The projects included in each of the four Design & Construction groupings were then arranged according to their operation and maintenance ranking of Fully Functioning, Partially Functioning and Not Functioning (Table 7).

Table 7: Distribution of project operation and maintenance ranking based on initial project design and construction quality over nine year time period (1999 to 2007).

Design / Construction Grouping	Fully Functioning	Partially Functioning	Not Functioning	Total
Sufficient | Sufficient	243	27	10	280
Sufficient | Nearly Sufficient	158	51	10	219
Nearly Sufficient | Nearly Sufficient	57	42	17	116
Insufficient | Insufficient	12	19	11	42
Total:	470	139	48	657

Again, because the sample size (total projects) for each of the four groupings varies, it is difficult to interpret the results in Table 7. Instead, if the results in each of the Design & Construction groupings in Table 7 are converted to percentages based on each groupings sample size, the results are more easily compared (Table 8).

Table 8: Percent distribution of project operation and maintenance ranking based on initial project design and construction quality over nine year time period (1999 to 2007).

Design &/ Construction Grouping	Fully Functioning	Partially Functioning	Not Functioning
Sufficient | Sufficient	87%	10%	3%
Sufficient | Nearly Sufficient	72%	23%	5%
Nearly Sufficient | Nearly Sufficient	49%	36%	15%
Insufficient | Insufficient	29%	45%	26%

The percent distribution data in Table 8 was then plotted according to project Design & Construction groupings for comparison (Figure 3).

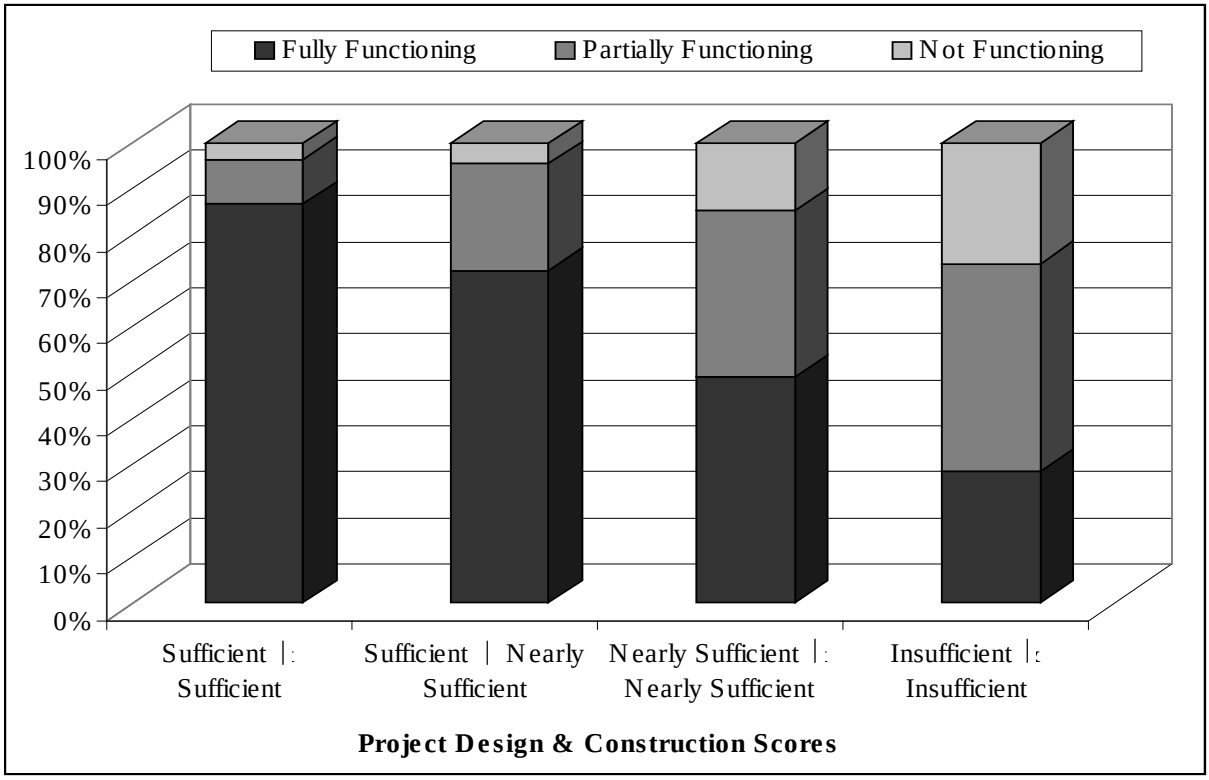

Figure 3: Percent operation and maintenance ranking based on initial project design and construction quality over nine year time period (1999 to 2007).

DISCUSSION

The results from Table 5 and Figure 1 indicate that 81% of PPK/PNPM projects constructed in 2007 are Fully Functioning after six to eight months of use. As these projects are literally newly completed, it was expected that the percent of Fully Functioning projects for 2007 would be closer to 100 percent. As equally unexpected is the 17% (22 occurrences) of newly completed projects that are ranked Partially Functioning after only six to eight months of use. Upon closer examination of the data, it was observed that of the 22 projects ranked Partially Functioning in 2007, ten were water projects (i.e., boreholes, pumps, hand-dug wells, and gravity water systems), four were toilet projects, two were micro-hydro turbine projects and

the remaining six were an assortment of other project types. The principal cause for ten projects (40%) being ranked Partially Functioning was due to incomplete construction (i.e., project construction had not been fully finished). Another seven projects (28%) were reduced to Partially Functioning status due to lack of project maintenance. To address the problem of incomplete construction, it is recommended that communities are not permitted to participate in any further PNPM funding cycles if they have unfinished projects. To address the problem of lack of maintenance, KDP facilitators must work with community members to plan for and organize regular maintenance to assure the project remains fully functioning. The two projects ranked Not Functioning in the 2007 sub-set are a kindergarten building (delayed start of project has resulted in construction beyond the project's funding cycle) and a water storage reservoir (1000 liter plastic tank), which was installed and connected to piped water supply but water was turned off because beneficiaries did not pay the water bill.

From Table 5 and Figure 1, in reverse chronological order (from 2007 to 2004), there is a decrease in the percentage of Fully Functioning projects from 82% in 2007 to 76% in 2006, to 60% in 2005 and 61% in 2004. For the same time period, there is an increase in the combined percentages of Partially Functioning and Not Function projects from 19% in 2007 to 24% in 2006, to 40% in 2005 and 39% in 2004. These results would indicate that either:

1) the percentage of projects completed as Fully Functioning in 2006, 2005 and 2004 were notably lower than in each successive year; or
2) that over time, projects that were initially Fully Functioning are now either Partially Functioning or Not Functioning and that projects that were once Partially Functioning are now Not Functioning.

As it is unlikely that initial project quality has varied widely over the past four years, then it is reasonable to conclude that there are causes for the observed decrease in project performance over time. From the project data, causes that contributed to the percent decrease in Fully Functioning projects over time were compiled and sorted by association into three categories. (The order of the causes listed below in each category is alphabetical only).

Operation and maintenance project related issues:

- Community unable to complete project construction because project funding exhausted.
- Inferior or unsuitable materials used to construct project.
- Initial construction quality is insufficient leading later to project failure or near failure.
- Initial project design by PPK/PNPM facilitator/consultant is insufficient leading later to project failure or near failure.
- Neglect because it is not clear who in the community is responsible for maintenance.
- Project construction deviates greatly from initial design.
- Substandard equipment selected for use in project.
- Technical skills necessary to operate and maintain project not available in community.

Operation and maintenance socio-economic related factors:

- Community conflict (external or internal) has halted use of project.
- Community unable to complete project construction because community unwilling to provided *swadaya* (community contribution) for project.
- Community unmotivated to complete project construction.
- Insufficient funds available in community to maintain/repair/replace system component(s).
- Project is no longer useful to community because project has fallen into disrepair.
- Project no longer used because external organization (i.e., Government of Indonesia or non-governmental organization) provides improved similar service to community (i.e., new health clinic, and/or electricity from grid, new water system).
- Reluctance and/or inability of community to acquire needed inputs to operate project.
- Some members of community unable to support and/or benefit from project because of their social or economic status.

Operation and maintenance problems due to accidents and hazards:

- Inopportune natural event makes project impossible to finish.
- Man-made force or event has damaged project.
- Unpredictable catastrophic natural event (*force major*).

The causes grouped in the accidents and hazards category are unpredictable and often occur without warning, thus making them nearly impossible to control or change. Therefore, these causes are not discussed any further. On the other hand, the causes in the other two categories (project related and socio-economic factors) are problems that need to be addressed to improve long-term program success. The socio-economic factors identified above relate to both problems that can and cannot be solved by PNPM program inputs. Some factors can be accounted for by PNPM staff, like coordinating with Government agencies and other organizations working in the area, and ensuring that PNPM projects are equitable for all socio-economic levels in the community. Then again, factors such as internal/external community conflict or ability of community members to acquire needed inputs to operate project are beyond the scope of the PNPM program to resolve.

Resolving the problems identified in the project related category would require greater input and supervision from PNPM staff and community project committees. Fundamentally, it requires an improvement in Quality Assurance and Quality Control on all project activities. This is very important, because as is discussed later in this report, the better a project is initially designed and constructed, the more likely it will remain Fully Functioning over time.

From Table 5 and Figure 1, in the combined sub-set 1999-2003, the percentage of Fully Functioning projects (79%) is greater than in each of the other years 2004, 2005 and 2006. Also for the combined sub-set 1999-2003, the percentage of Not Functioning projects (3%) is smaller than in each of the other years 2004, 2005 and 2006. This unexpected difference is most likely explained by the smaller sample size (a total of 33 projects) of this sub-set, which constitutes only five percent of the total number of projects reviewed for this report. This small of sample size may make comparison with subsequent years impractical. Other possible explanations for the higher than expected percent values for sub-set 1999-2003 include a potentially greater propensity by earlier communities for continued project maintenance, and/or a change to PPK program practices employed during the initial five years (1999 to 2003) of program implementation verses the later four years (2004 to 2007).

In regard to Figure 2, overall, 93% of all PPK/PNPM funded micro-infrastructure projects are still Fully Functioning (72%) or are at least Partially Functioning (21%). Of the 7% of all projects that are Not Functioning, 52% are water projects, 17% are electricity generating projects, 13% are toilet projects and 13% are building projects. The remaining projects (6%) are an assortment of other project types.

From the overall total of 48 Not Functioning projects (Table 5), 14 projects (29%) are Not Functioning because of a broken pump, motor and/or generator. Also, when examining all 657 projects, 2.6% of all projects reviewed for this report are Not Functioning or are only Partially Functioning because of a broken pump, motor and/or generator. From interviews conducted during site visits, the most common reason provided by community members to explain equipment failure was due to the substandard quality of the mechanical equipment procured. Therefore, it is recommended that higher quality motors, pumps and generators are made available for project procurement to increase project sustainability. Also recommended is finding alternative energy devices that can provide the same performance level as fossil fuel consuming equipment but do not require the same economic inputs needed to purchase fuel. These green technologies would also diminish the negative environmental impact of localized site contamination caused by spilt fuel and oil required for fossil fuel burning equipment.

Table 8 and Figure 3 provide a comparison of project operation and maintenance performance over a nine year period (1999 to 2007), as affected by initial project design and construction quality. Overall, the results in Table 8 and Figure 3 reveal that as initial design and construction quality decreases, (i.e., from a maximum of Sufficient | Sufficient down to a minimum of Insufficient | Insufficient), so does the observed number of projects ranked Fully Functioning over the same nine year period. Of the 280 projects with combined Sufficient design and Sufficient construction scores, 243 of those projects (87%) are still Fully Functioning. In other words, 87% of projects that were properly designed and well built when completed remained Fully Functioning within a nine year period. And only 3% of projects within that same Design & Construction grouping of Sufficient | Sufficent were ranked Not Functioning. Of the 10 projects that make up the 3% Not Functioning operation and maintenance ranking, four projects are Not Functioning due to broken equipment (motors and pumps), two projects are Not Functioning because of incomplete work, two projects are Not Functioning due to socio-economic reasons, one project is Not Functioning because of internal village conflict, and the last project is Not Functioning because it is no longer useful.

The results from Table 8 and Figure 3 discussed above are overall better than the percent results in Table 6 for the 2007 sub-set, which is surprising, considering that all the projects in the 2007 sub-set are newly completed and therefore, should be Fully Functioning given they only have six to eight months of use. Also, the results from Table 8 and Figure 3 are much better than the overall 72% Fully Functioning status and 7% Not Functioning status of all projects reviewed in Figure 2.

RECOMMENDATIONS

Reduce Mechanized Equipment Operation and Maintenance Issues:

1. Identify high quality makes and models of commonly purchased project equipment (i.e., pumps, motors, generators, turbines and boat motors) and determine how best this equipment can be ordered, purchased and delivered to project work sites (this has already been done to some extent for micro-hydro turbines).
2. Explore alternative energy devices (solar, wind, water and biogas) that can provide the same performance level as fossil fuel consuming equipment but that do not require the same continued economic inputs needed to purchase fuel.
3. Provide system operator(s) with specialized technical training on operation, maintenance and repair to mechanized equipment.

Maintain the Number of Fully Functioning PNPM Projects Over Time:

4. Coordinate with Government of Indonesia and other external organizations to prevent redundant projects.
5. Assess whether the community is capable of generating the needed funds to maintain, repair and replace project component(s).
6. Ensure the highest quality of initial project design work is completed for each project and assure community members follow final project design.
7. Ensure the highest project construction quality, including preventing the use of inferior or unsuitable materials.
8. Ensure that the community's promised contribution to the project is realized.
9. Provide on-going supervision and motivation during project implementation to assure full completion of project works by the end of the funding cycle.
10. Work with community members to plan for and organize regular maintenance to assure the project remains fully functioning.

CONCLUSION

Of the 657 PPK/PNPM micro-infrastructure projects built between 1999 and 2007, 470 projects were assessed to still be Fully Functioning (72%), 139 projects were assessed to be Partially Functioning (21%), and 48 projects were assessed to be Not Functioning (7%).

When the same project data set of 657 projects was divided into five yearly sub-sets, it was observed that looking backwards in time from year 2007, there was a decrease each year in the percent of Fully Functioning projects in the first three years (2007, 2006 and 2005). In year 2004 the percent of Fully Functioning projects leveled off and was approximately the same as in year 2005. Due to the small number of projects reviewed between 1999 and 2003, it was necessary to include all the project data for these years into one combined sub-set (1999-2003). The 1999-2003 combined sub-set had a total of 26 still Fully Functioning projects (79%), six Partially Functioning projects (18%) and only one Not Functioning project (3%). Only the percent results for sub-set 2007 are better than those for combined sub-set 1999-2003. This difference is not readily explained, as it could be influenced by the small sample size (a total of 33 projects) of the combined 1999-2003 sub-set, community operation and maintenance inputs over the past four to nine years, and/or by PPK program practices employed during the initial years of program implementation.

The decrease noted above in the percent of Fully Function projects would indicate that over time, some projects that were once Fully Functioning, later become Partially Functioning or Not Functioning. From the data, it is clear that as the percent of Fully Functioning projects decreases over time, the converse is observed for the percent of Partially Functioning and Not Functioning projects. The decrease in the percent of Fully Functioning projects and subsequent increase in the percent of Partially Functioning and Not Functioning projects indicates the inability of some beneficiary communities to adequately operate and/or maintain over time the micro-infrastructure projects provided through PPK/PNPM funding. Causes for increases in Not Functioning projects were compiled using the 657 projects identified earlier. A variety of causes were found to be project related (i.e., design, construction or maintenance issues), other causes were socio-economic in nature, and a few problems were caused by accidents or hazards. From these three casual groups a list of ten recommendations was derived to: 1) reduce mechanized equipment operation and maintenance issues, and 2) maintain the number of fully functioning PNPM micro-infrastructure projects over time.

An additional analysis was completed in order to determine the affect, if any, that initial design and construction quality had on project operation and maintenance performance from 1999 to 2007 (a nine year period). Results indicated that as the initial design and construction quality of a project decreases (from Sufficient to Nearly Sufficient to Insufficient), so to does the observed number of Fully Functioning projects. This correlation suggests that the better a project is initially designed and constructed, the more likely it will remain Fully Functioning over time

FURTHER INFORMATION AND DETAILS

For further information and details regarding the data used in this report, refer to the 16 Mission Summary Reports and the 334 detailed Village Reports compiled for the World Bank Office - Jakarta.

APPENDIX A

FULLY FUNCTIONING = Infrastructure is operating as intended, 100 percent of the time.


Rainwater storage reservoir is intact, connected to roof gutter system, with all faucets and piping intact.


Culvert has no cracks, has graded approaches and has no vegetation or debris blocking entrance/exit.


Building (i.e., school or clinic) is used regularly by community, is structurally intact and complete and can be locked and secured.


Wooden boardwalk is complete, intact and sturdy.

APPENDIX B

PARTIALLY FUNCTIONING = Infrastructure is operating at a lower level than intended and/or operating only part of the time.


A hand-dug well is missing its pulley, which results in water being drawn from the well using contaminated buckets.


Cement slab walkway surface is deteriorating and breaking apart forming holes making passage problematic.


Boat dock provides boat mooring only at high tide because the boat dock is not long enough to reach deep water at low tide.


Road (Gravel or Dirt) has uncut vegetation growing on travel surface and along shoulders.

APPENDIX C

NOT FUNCTIONING = Infrastructure is not operating at all.


Electric generator motor is broken so no electricity can be produced.


Village toilet has full septic tank or no septic tank at all.


Bridge is no longer passable to vehicular traffic and poses serious risk of harm to pedestrians.


Pump for water system is broken or not strong enough to pull water up from borehole.