Impact assessment to measure the success of implementation of rural community engagement projects. A Case Study

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***Abstract*—This paper describes how the use of an impact assessment reveals unknown information to project teams who conduct community engagement engineering projects in rural and distant villages. The paper depicts a "tried and tested" case study to describe how the impact assessment is done and the information revealed. The second phase of the Gwakwani project included the installation of off-grid solar home systems in the community. An assessment was later done which measured the impact of the technology in the area, using survey analysis.**

Keywords* — *Impact assessment, community engagement engineering projects, rural, Gwakwani, solar off-grid, survey

I. INTRODUCTION

The Gwakwani rural community engagement project, embarked upon by the University of Johannesburg (UJ) kicked off with Phase 1 in 2014 with the successful installation of a solar powered borehole pump, cellphone charging station and equipment monitoring communication system. Long before Phase 1 begun, it had been reported that a number of companies had implemented systems in the village and did not return to determine the success of the systems or whether the objectives of the community were met [5] [6].

This behavior is not unfamiliar to rural community projects and leads to unfortunate communities being "forgotten" in community service schemes. Private companies are keen to support community service projects to gain the marketing and product exposure but tend to leave out the stage of evaluation, to determine if the installed system measured up to the expectations of the community [13]. This is due to the maintenance costs that may be possibly incurred if a technical issue arises and also due to the long distances between the rural community and the stakeholders.

It should be encouraged that project teams and external companies verify if project objectives were met. This would allow stakeholders to understand whether the objectives of the community were met and whether the stakeholders positively impacted the community through the use of the technology [8]. This assessment could bridge the knowledge gap with regard to the strengths and weakness of the system, the community expectations and the manner in which the project was conducted. The impact assessment may also indicate any weaknesses in the social behavior and management of the project which could impact future work in that respective community. The remainder of this paper follows with section II outlining a brief background with section III presenting a project development framework, with the integration of an assessment strategy on how to evaluate community engagement projects. Section IV presents the implementation of the proposed framework with section V presenting the verification and validation of the proposed framework. The paper is concluded in section VI with the conclusion and references are listed. It must be emphasized that the work presented only focuses on the implementation part of this framework.

II. BACKGROUND

As part of a maintenance scheme for the Gwakwani project, it is necessary to continuously assess the wellness of the installed systems and the influence Phase 1 of the Gwakwani project had on the community in the longer term. This assessment was done through the use of a community assessment [12]. In light of this, six months after the system implementation of Phase 1, it was evident that the village was not only able to sustain their daily water needs but also be able to produce small vegetable gardens, as shown in Fig. 1, as a result of the excess amount of water pumped from the solar powered borehole. Along with this was the erection of an additional water tank on the property.

Fig. 1. Newly planted vegetable garden in the Gwakwani rural village.

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The assessment also included a focus group discussion between community members and members of the university project team. It was imperative, through this assessment, to understand the daily life of a Gwakwani villager, so as to optimally identify a suitable problem to tackle. The assessment revealed that the lack of electricity still posed an issue to the community [2].

On a typical day in this small Venda community, the scholars in the community would travel 5km to and from school by foot. The scholars would leave early hours of the morning (before the sun has risen) and walk back to the village, once the school day was complete. The scholars would only arrive back to the community during the latter parts of the day, leaving homework activities to be dealt with during the evenings.

Light would be provided to each household through the use of candles. However scholars found it difficult to use candle light to conduct academic activities in the evenings, as the light was visually straining to the eye and guardians of the household were generally hesitant to allow scholars to use candle light in the evenings, due to a high safety risk. This method of lighting was also not a sustainable option and resulted in a recurring cost.

During the evenings, villagers were hesitant to walk between dwellings in the village due to the lack of lighting outside of the dwellings. Fires were made outside to allow villagers to cook and boil water but this did not provide sufficient lighting for walking between dwellings, let alone conduct these activities. These fires posed a safety risk and villagers were fearful due to not only a lack of visibility in the evenings, but also any environmental hazards (such as poisonous wildlife and hazardous plants) that pose a high safety risk.

These issues all deemed to be the highest concern to the community which led to Phase 2 of the Gwakwani project.

The University of Johannesburg, together with Schneider Electrical, participated in Phase 2 of the project. The project followed a tailored Engineering Design process, with the SANS 15288 standards used as the platform of the methodology. The framework led to the installation of solar off-grid lighting systems in every dwelling in the community. In addition to this, individual community members were given portable solar powered lights as well. These lighting systems were intended to meet the requirements of the community.

The success of this project was measured through the use of a survey. The survey was to output results that would indicate if the system requirements were met from the perspective of the community.

III. FRAMEWORK

Community Engagament is defined as "the process of working collaboratively with and through groups of people affiliated by geographic proximity, special interest or silliar situations to address issues affecting the well-being of those people [15]. It is often conducted by Non-Governmental Organisations, volunteers from the public and by humanitarians. However community engagement activities can be spread to the engineering environment by introducting such activities into engineering curriculum within engineering institutions. Community engagement or service-learning has proven to be extremely beneficial in cultivating engineers into 'community engaging experts' across the world by giving students the opportunity volunteer and gain life skill knowledge, appreciate the hands-on experience that could further students in career goals, gain a further sense of civic duty and overall become more connected to the community [16].

With the merging of community engagment into engineering, it brings about the need for understanding project success and failure. Literature describes a key element to project success in commumty engagament is through the social aspects.

Engineers are used to the standard "hard" egningeering approach to problem solving but tend to ignore the social aspects of engineering. This is because engineers feel there may be a transfer in leadership from the highly qualified engineer to the layperson [17]. James Scott describes project failure being attributed to the fact that experts design and implement grandiose plans often in faraway cities and countries without taking local tradition into account [18]. The social aspects of engineering could be the reason for failure of multi-stakeholder projects.

Multiple models exist, however not all models can prove to be successful and so the standard engineering approach to solving design problems is through the use of the well known "Engineering Design Process" [1]. However, this basic 5 step process does not account for the important aspects within a community project that must be considered during analyis.

Literature describes the gap between engineering and community development to be the following [14]:

- Engineers continue to believe in the main premises of "development and modernisation". That technology development will lead to growth, human satisfaction and welfare.
- Engineers continue to believe in the power of "technology to transform society" and hold onto the assumption that technology development can happen independently from society, culture or politics. This belief is highly problematic in community projects as it places engineers as experts for technology development and community developers as passive receivers for technology already developed.
- In terms of cultural development, most engineers assume that communities are homogenous entities with one voice and can be treated as a "client" or "customer". Heterogenous complexity is a key issue in community development and must not be ignored.

This study was formed on the basis of changing the current mindset of engineers and incline engineers to engage with stakeholders and community members in community engagement activities. The study was intended to introduce a framework which will take social aspects into account and reduce the risk of failure due to a lack of social interaction. The schematic in Fig. 2 represents a tailored framework (represented from a high-level) adapted from the exisitng SANS 15288 Systems Engineering Life Cyle standards [4], with the inclusion of community assessment procedures, project selection processes and number of other processes, such as site visit procedures as well as verfication and validation methods. The framework provided the methological approach from which Phase 2 of the Gwakwani project was conducted.

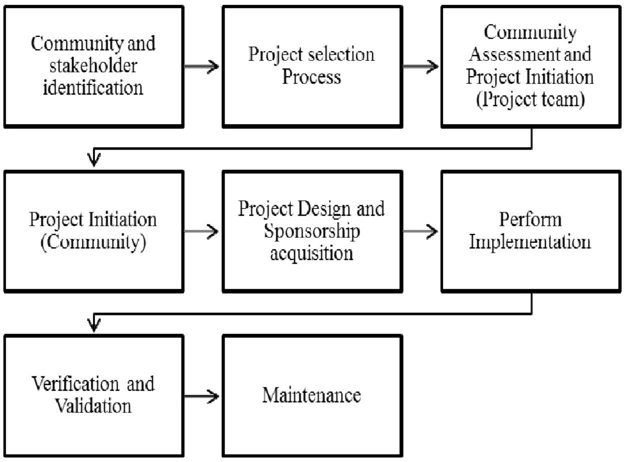

Fig 2. A high – level Systems Engineering tailored framework with community engagement integration for small scale community engagement engineering projects.

The community and stakeholder identification stage allows for a community to be carefully selected and the facilitating team's (the project team) needs to be identified. The chosen community will go through a project selection process. The process follows a basic 3 step approach taken from the Michigan State University on how to select a community service project.

The process includes, brainstorming communmity issues of interest or communities as a group, selecting a community or communities that may have emotional effects on the project team and then conducting a survey, which in this case includes community assessments and site visits [9].

The community assessment relies largely on the initial cultural negotiations which takes place at the first site visit. This is to happen on the grounds of the community. The community assessment allows for the project team to develop a set of requirements for each issue within the community and each issue is then individually rated based on a set of criteria such as, benefits to the community served, money and hours spent per individual, involvment, diversity and the value of the project as a demonstration to other university groups and the general public. Once each issue and community is assessed and then selected.

The project team would then commence with initiation of the project. The project team is to propose the information to the community leaders where both parties may engage in an agreement for the community issue to be solved. Solutions are then studied through a Project Design process and a final solution is chosen to satisfy the system requirements. A sponsorship acquisition process may commence so as to obtain resources for the chosen solution. The solution will then be implemented in the community. After an appropriate time period later, verification and validation may take place so as to validate the System and User Requirement Specification. Thereafter, a maintenance schedule is be implemented.

For the purposes of this paper, the "Perform implementation" and "Verification and Validation" stages will only be discussed.

IV. IMPLEMENTATION

The implementation began with following the intial steps of the framework from community and stakeholder indentification, to project identification and selection. The community assessment tool played a vital role in the entire project as it firstly allowed for a set of requirements to be drawn up and secondly, for the project team to conduct onsite inspections. This assessment was initiated through a series of cultural negotiations, which took place on the village grounds. The negotiations included community representatives and project team leaders along with a translator. The negotiations concluded with a successful agreement between both parties for the project to be conducted, within the specifed constraints. This agreement set the foundation for a helathy realtionship between stakeholders which made it easier for the project team to conduct work in the community. Throughout the remainder of the project lifecycle the translator would maintain communication with community.

With a suitable solution selected for implementation, the Project Team departed to the Gwakwani village on the 15th of July 2015.

The Project Team consisted of technicians, volunteering engineering students, administration staff, translators and engineering lecturers. The following schematic in Fig. 3, shows how the installation was planned to be conducted.

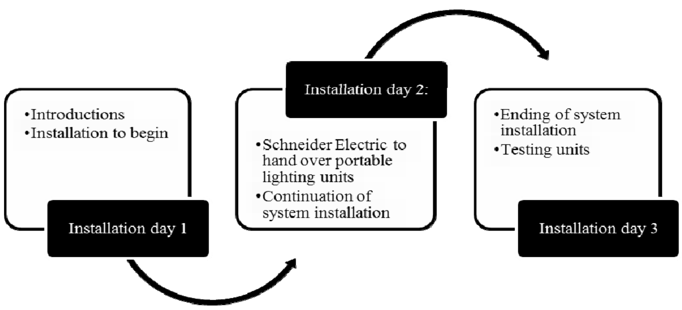

Fig. 3. Process diagram for implementation strategy

The Project Team planned a 5 day trip, in which 2 days were used for travelling and 3 days were used for installation of the lighting units. The first day of installation included the introduction of the Project Team to the community and a general information session on the plans over the implementation period.

The Project Team commenced with installation on the first day. On the second day of installation, it was planned that Schneider representatives were to visit the village in order to hand over the portable lighting units to the community [7]. The third day included the installation of the remaining units and for the testing of the units after sunset at 18:00 pm to verify full functionality.

The installation began where the UJ team split into 2 smaller teams, all of which had a translator to communicate with the respective villagers of that householder. The translator played a pivotal role in the success of this installation as negotiations, communication and information were facilitated by the translator. The teams would visit the property, where the translator would make contact with a representative of the household and ask for permission for the team to enter and commence installation. The system would be installed in an easily accessible room. A number of dwellings on the property were mud huts which meant that the team would have to find a secure enough position in the hut to install the system. Fig. 4 depicts the system equipment installed in a dwelling.

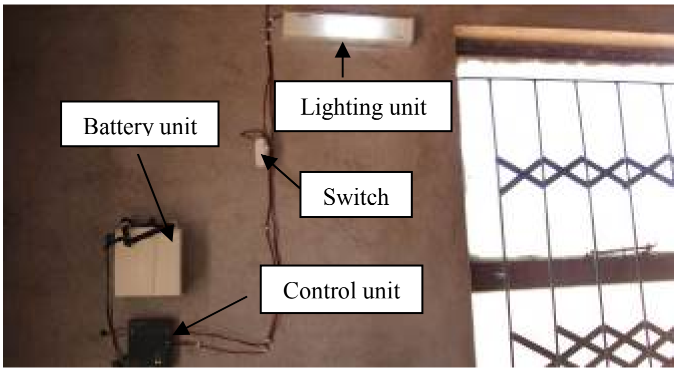

Fig. 4: Solar off-grid lighting system installed in a dwelling.

The lighting unit consisted of a 12 V battery, a switch, a 3 A solar charge controller (with a trickle charge mechanism), which included a USB charging output. The system also include a 5 W LED lamp, which is to last 8 to 15 hours when powered from the external battery. Each household was equipped with 2 lamps [3]. Fig. 4 shows a system installed in one of the dwellings. The system was powered from a 10 W solar panel, which was mounted on a steel mast and erected, north facing outside the each dwelling.

Once the installation was complete, the representative of the household would be informed on the operation of the system. This process was repeated for the remaining dwellings in the village, until all units were installed. The last stage of the implementation was to test the units before departure.

The team tested the units on the final evening of installation, to which all the units were deemed fully functional and were system healthy. The villagers also made use of the portable lighting units to conduct the evening activites, when not in the household. Shown in Fig. 5, is a villager cooking oustide aided by the portable lighting units.

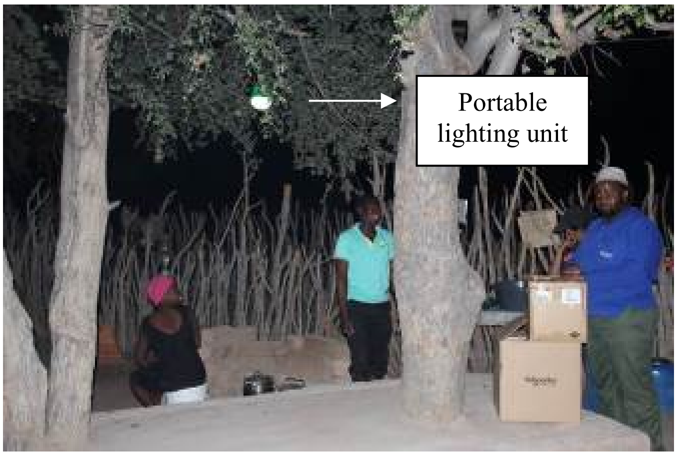

Fig. 5. Villagers cooking under the portable lighting unit outside dwelling.

The Project Team was able to install 52 solar lighting units in the community. It was vital to measure the impact of these units on the community, in order to determine if the objectives of the community were met.

Six months later the Project Team visited the village to conduct a survey to determine the success of the installation. The success of a project is determined by several factors such as meeting user requirements, meeting timelines and budget constraints, satisfaction of customers and achieveing the purpose of the project [11].

This study focused mainly on the aspect of meeting user requirements and to what extent the community was satisfied. This survey consisted of a number of questions all pertaining to the installation of the system and the knowledge around it.

V. VERIFICATION AND VALIDATION

The verification and validation of a community engineering project is imperative to the complete success of these projects. This is for several reasons such as accountability, to secure future funding, to check the project's progress against original plans, to learn from experiences and to motivate staff and volunteers. There are a number of ways to evaluate the success of a community project which include a questionnaire or survey, feedback forms, interviews and focus groups [10].

This form of verification and validation can be foreign to the discipline of engineering and reinforces the need for this work in this field.

A well-known method of analyzing qualitative data is through the use of Likert scales. Likert scales are useful in indicating a participant's preference or degree of agreement with a statement or set of statements [13].

The verification and validation of this project was done through the use of a survey. The survey asked a number of Likert scale questions as well a number of Dichotomous questions.

The survey was categorized into the following indicators, technical evaluation (indicated in blue), installation process and social issues (indicated in red), maintenance and knowledge transfer (Indicated in green) and customer satisfaction (purple). The survey was answered by 15 individuals of the community. Fig. 6 and 7 depict the results obtained from the survey.

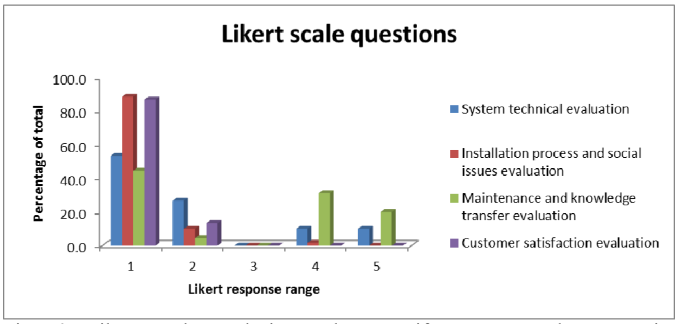

Fig. 6. Likert scale analysis used to verify system and community requirements

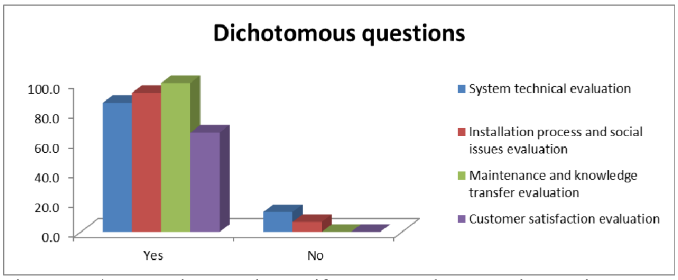

Fig. 7. Yes/No questions used to verify system and community requirements.

Fig. 6 and 7 represent the results obtained from the individual survey questions. The survey was structured so as to indicate favorability with the answers "Strongly Agree", "Agree" and "Yes", in Fig. 6 and 7 respectively. Examining both figures indicate that the strongest performing category was the installation process and social issues, indicated in the red. This would suggest that the community was satisfied with the manner in which the systems were installed in each and every dwelling. There is also an indication that the community was satisfied with the social aspect. The community gave an indication of being satisfied with stakeholder negotiations and that members were continuously informed and communicated with throughout the entire installation process.

The second strongest performing category is the customer satisfaction, which describes the community's personal feelings towards the system, the impact it has made on the individual lives of community members and if expectations were met. There is indication that the community is satisfied, with the outcome of the system installation. It is deduced that this installation fits in with the future plans of the community and that a positive impression has been left so as to allow for further work to be done in this community. This result also demonstrates that the community feels that there is no need for further improvement to be made on the system.

The System technical evaluation (indicated in blue), displays the systems overall performance in the eyes of the user. The survey indicated a satisfaction towards the system technical performance, however, there have been remarks for some improvements. The system is designed to function for 8 to 15 hours per lamp, before it turns off, to allow for the battery to recharge. However the system lasts for 3 to 4 hours due to the dual lamp setup, and this technical trait of the system was viewed as a disadvantage for the system as this resulted in the weakening of the systems technical evaluation. Community members would have preferred if the system was to function for longer periods during the evenings. The system also tends to function poorly on rainy days, which was also a disadvantage to the technical evaluation. Overall the system technically satisfies the community but there is room for improvement.

The last category which had the poorest ratings was the maintenance and knowledge transfer category (indicated in green). The community felt unaware of what actions to take if the system was dysfunctional for some reason and who would take responsibility for the system in the long term. This issue is not uncommon to community service projects, as stakeholders tend easily forget or skip the maintenance phase of these projects. This could be due to the distance between the communities and the stakeholder, due to the cost associated or the time frame for the installation, testing and handing over. It should be made clear on the onset of the project, during the requirements phase, regarding any maintenance or follow up measures so that all stakeholders are aware.

Another floor identified was the lack in knowledge on the safety risks of using the system and this indicates poor knowledge transfer. The community was however, well informed on how to operate the system and felt comfortable operating the system individually.

VI. CONCLUSION

It was evident from this paper that it is clearly vital to assess the impact that certain technology solutions have had on a community, as it may not necessarily be meeting the requirements of the community. This impact survey has allowed the project team (UJ) to assess the weakened areas of project development and strengthen it. The work done in this paper is meant to encourage the use of impact assessments on further community engagement projects.

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