Proceedings of the First Australian International Conference on Industrial Engineering and Operations Management, Sydney, Australia, December 20-21, 2022

A Socio-Technical System for Rural Community Engagement: the Gwakwani Project

Suné von Solms
Department of Electrical Engineering
University of Johannesburg
Johannesburg, South Africa
svonsolms@uj.ac.za

Hannelie Nel
Postgraduate School of Engineering Management
University of Johannesburg
Johannesburg, South Africa
hannelie.nel@worley.com

Abstract

The United Nations (UN) defines community development as "a process designed to create conditions of economic and social progress for the whole community with its active participation and the fullest possible reliance on the community's initiative". Within the context of a community engagement project, the technological solution and systems installed in the community to solve the problem, cannot be viewed in isolation. The community engagement project must be viewed from a socio-technical perspective, where the design, development and implementation of the solution must consider the impact on the community and their interaction with the solution. The implementation of technological solutions to community needs must therefore consider both the societal and technological inter-relationships; as well as creating an awareness of the sustainability and impact of the engineering activity on the social, industrial, and physical environment. This paper considers rural community engagement as a socio-technical construct and discusses the value and contribution of technological intervention within the social and economic system of a rural community towards self-sustenance.

Keywords
Socio-technical systems, community engagement

1. Introduction
In South Africa, community engagement is one of the three pillar responsibilities of higher education, alongside research and teaching (South African Council on Higher Education, 2010). The spirit of transformation of South Africa's Higher Education promotes tertiary institutions to develop social responsibility and awareness amongst students to engage in community service programmes for social and economic development (Department of Education, 2022). In this context, community engagement projects undertaken by universities can be mutually rewarding: technology introduced to communities can contribute to the sustainable development and upliftment of the local community; whereas academics and students are exposed to real-world problems and expected to solve these problems in the community for the benefit of its members (Nel, 2018). In a case study of accelerating access to electricity services in a Kenyan village, the authors, Uhsrud et al. 2015, state that a "socio-technical systems perspective emphasizes that technology and society develop in mutual interaction – they co-evolve, creating socio-technical change, not only technological change". The aim of community engagement would be for the village to achieve economic self-sustenance (Uhsrud et al. 2015).

However, tertiary institutions face several challenges associated with the dynamics and complexity of community engagement. These may include access to finance to fund the project; ineffective communication amongst the stakeholders of the projects; lack of community buy-in and community participation leading to distrust; geographical distance and inaccessibility; potential negative environmental impact; lack of support and insufficient training; and lack of maintenance after the project has completed (Nel 2018; Uhsrud et al. 2015; Uhsrud et al. 2011).

The United Nations defines community development as a "process designed to create conditions of economic and social progress for the whole community with its active participation" (United Nations 1955); and sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UN Documents 1987). When reflecting on the challenges of community engagement and development, the following are important aspects to consider: active participation of the community and the development of local expertise; sustainability of the social or technological interventions in the community; the potential of the intervention to create and promote progress in the community; and creating economic viability (Ahlborg and Sjöstedt 2015). In the systemic evaluation of rural telecommunications infrastructure in South Africa, Nepal and Petkov (2005) caution that "the mere deployment of rural telecommunications infrastructure does not necessarily imply economic development". The authors advise that rural communities need to be "educated with regards to the use, benefits, and the importance of taking ownership and protecting the rural telecommunications infrastructure".

Within the context of a community engagement project, a technological solution or system installed in a community to solve a defined problem cannot be viewed in isolation. Therefore, the design, development and implementation of the solution must consider the impact on the community and their interaction with the solution now and in the future. This complexity, interdependence and multi-dimensional facets of a community engagement project calls for a socio-technical approach in the design and execution thereof (Ahlborg and Sjöstedt 2015; Clegg 2000; Nel 2018; Uhsrud et al, 2011; Schöttl and Lindemann 2015). Uhsrud et al. (2015) support the interdependent nature of socio-technical systems with the following: "Technology and society shape each other and are deeply intertwined".

This paper considers rural community engagement as a socio-technical construct, and presents the engagement with the Gwakwani rural community and the Project Office hosted in the Faculty of Engineering and the Built Environment at the University of Johannesburg as a case study. The Gwakwani Village is situated deep in the Limpopo province of South Africa and is considered rural due to its remote geographic location and consequent underdevelopment. The paper is structured as follows: Section 2 provides an overview of the Gwakwani Village and the community's needs and challenges. Section 3 discusses the methodology employed in the longitudinal study and presents the case for action research. Section 4 provides the outcomes of the study by describing the key characteristics of socio-technical systems and its application in the Gwakani community setting. The case study is discussed within the context of the technical, financial, social and environmental aspects of the system. The paper is concluded in Section 5 with a discussion of the value and contribution of technological intervention within the social and economic system of a rural community.

2. Overview of the Gwakwani Village

Gwakwani is a small, rural village located in the northern part of the Limpopo province in South Africa. The village consists of seventy people making a living from subsistence farming and government grants, and their spoken language is Venda. The village lacks any source of electricity supply, direct mobile cellular connection and municipal water or sanitation services usually provided by utility suppliers. Electricity and access to electricity is a symbol of progress in rural communities, and despite the multiple requests made by the villagers for electricity supply from service providers, their requests are denied as their connection to the power grid is financially unviable and outweighs the advantages of connecting this small rural community to the grid. Due to the absence of electrical power, the village also faces the dilemma of not having a sustainable supply of clean water. The local municipality installed a diesel pump to supply the village with drinking water pumped from a bore hole which is then stored in a 10 000-litre water tank. The cost of running the diesel pump proved to be a financial strain on the small village as most residents are subsistence farmers whose income is supplemented by government grants.

These factors resulted in an intermittent diesel supply, which lead to a lack of a reliably consistent supply of drinking water. On average, one villager had access to approximately 25 litres of water per week for drinking and cooking. The intermittent unreliable diesel fuel supply, leading to a lack of drinking water from the borehole, put severe strain on the self-sustainability of the community. In addition to the limited water supply for drinking and cooking, the opportunity for subsistence agriculture was also limited as the only water for this application was to be collected from a distant river source.

Cellular network reception is available only in isolated spots in the village and the lack of an electricity supply results in the inability to recharge batteries of cellular mobile devices. The villagers would resolve this issue by visiting the neighbouring village with an electricity supply and paying a fee of $ 0.50 for a single mobile device recharge whilst waiting on location for the duration of the recharge. Figure 1 provides an overview of the Gakwani Village geographical location.

Figure 1. Location of the of Gwakwani Village

3. Methodology

The project team at the University of Johannesburg consists of academics, researchers, and students in the Department of Electrical Engineering; and one of the members of the Gwakwani Village was elected to represent the village members on the project team to ensure effective communication. The University project team was established in 2014 and was searching for a relevant rural community engagement project to model as a socio-technical construct. The project industry funder, in turn, required an authentic project to support its' social business imperative. After an extensive national survey, the Gwakwani Village was chosen for the work because the university project team and the project industry partner both considered Gwakwani to be an interesting and innovative case study, inclusive of extensive local participation and reachable within a day's travel by road. After initial introduction and negotiation, the village members confirmed their willingness to participate in the socio-technical study towards improvement of their standard of living and economic viability.

Schöttl and Lindemann (2015) state that the role of people must be characterized and integrated in planning and developing a socio-technical system. In a sincere attempt to understand and integrate the needs of the community members in the design and delivery of technological solutions for their potential benefit, Phase 1 of the Gwakwani project was initiated in 2014 with the implementation of a solar borehole pump system in response to the necessity expressed by the villagers for a sustainable water supply (Naidoo and Meyer 2017). The community clearly indicated that a constant and reliable water supply was their primary human need for sustainable life in the village, and hence this requirement was addressed first and as a matter of urgency.

In 2015, Phase II was initiated with a qualitative study and "community assessment through a series of intensive cultural negotiations between community representatives and the project team leader [who communicated with the villagers through the translator]. The community assessment included a brief group discussion with the community and a site inspection where possible technical aspects of the community could be assessed for a community project. The assessment revealed that the lack of lighting posed the biggest concern to the community as this prevented scholars in the community from completing any academic activities in the evenings and the community members from performing evening tasks" (Naidoo and Meyer 2017).

Action research was employed as the research methodology where the interaction, activities, experience, and findings of the project were recorded by the researchers throughout the process. Action research was defined by Reason and Bradbury (2001) as follows:

> "a participatory, democratic process concerned with developing practical knowing in the pursuit of worthwhile human purposes, grounded in a participatory worldview which we believe is emerging at this historical moment. It seeks to bring together action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern to people, and more generally the flourishing of individual persons and their communities".

The context of the research, namely, to consider rural community engagement as a socio-technical construct, demanded participation of several stakeholders in a project that is value-laden, personal, and often subjective in its execution and consequence. Furthermore, the research was not conducted solely for its own sake, or for contribution to the body of knowledge only; but in principle for the practical intervention, learning and value that it brought to its participants. Working in a rural community in South Africa, or any country for that matter, demands of the researchers and participants to respect indigenous, theoretical, and practical knowledge – and that the actors genuinely and earnestly seek to understand and address the issues confronting rural community members (Brydon-Miller and Greenwood 2003). The potential solutions or interventions that are brought about by action research should provide the recipients with the support and resources that fit their own cultural context; and be determined by extensive participation of the community members (Brydon-Miller and Greenwood 2003).

Action research was chosen as the most appropriate research methodology for its' unique research approach and philosophical view. The research design included both qualitative and quantitative research, employing interviews, data collection, observation, and assessments. This paper presents the qualitative outcomes of the action research, namely the consideration of the key characteristics of a socio-technical system (technical, financial, social and environmental) as applied in the Gwakani rural village. Several project team meetings were held where the team members reflected on the project challenges, successes and failures; and where new and innovative approaches and solutions were considered. These ideas would then be shared with the village members, who either rejected or accepted them; or added their own ideas for further development. During this iterative process of reflective learning, the project team came to understand and value the unique challenges of rural community engagement; empowering them with knowledge and skill that could only be acquired through empathetic engagement with the rural village members.

4. The Gwakwani Project as a Socio-Technical System: outcomes of the action research

The core philosophy of socio-technical theory advocates that all technical and social elements be considered when seeking to design a new system or promote change in an organization (Davis et al. 2014; Nel 2018). Furthermore, all aspects of a system are interconnected, interdependent, equally important and need to be jointly designed (Clegg 2000). Two further attributes of socio-technical systems are that such a system is open and embedded within an external system and can consequently be influenced by environmental conditions. Secondly, the system must be flexible enough to adapt to and manage changes imposed by the external environment and is continually improved by new developments or changes (Maguire 2014).

Clegg (2000) provides critique of existing applications of socio-technical systems and argues that the "application and diffusion of sociotechnical principles and practices have been disappointing". Davis et al. (2014) calls for an extension of the theory of socio-technical systems thinking in applying it to new and novel situations; with Nepal and Petkov (2015) stating that further research is required in the application of systems thinking in community engagement and involvement. Defining rural community engagement by universities as a socio-technical construct and applying socio-technical principles and thinking in this context is a relatively new application of the theory. Examples of this approach include work by Uhsrud et al. (2011), who implemented solar mini-grids employing socio-technical systems in the Sunderban Islands of West Bengal, India.

Similar work is found in the case study conducted by Ahlborg and Sjöstedt 2015, who employ a socio-technical approach to rural electrification in Tanzania using off-grid mini-hydropower. Their work was funded and led by an international non-governmental organization, as opposed to a university. The authors of the Tanzanian case study confirm that few studies apply a socio-technical perspective to small-scale energy systems in East Africa (Ahlborg and Sjöstedt 2015).

The fundamental premise of socio-technical systems is that technology and the community cannot be viewed as separate from each other, and that the implementation of the technological solutions to community needs must consider the societal and technological inter-relationships. The benefits of successful socio-technical systems are that technology introduced to the community can contribute to the sustainable development of the local community. Also, the community can be uplifted, and the solutions may assist in alleviating poverty, social inequality, the digital divide or environmental problems. The implementation and delivery of basic technology and services can become a catalyst for awareness of the community's ability and personal gains in self-development and sufficiency. Development can reduce the local community's dependence on external grants and funding and in many instances, the introduction of technology into a community, especially a deeply impoverished community, brings hope which is a catalyst for further development.

4.1 Technical Solutions

Electrification by a power utility of the Gwakwani rural area was financially unviable; and consequently, the project team found that the most promising method for sustainable development in the community was through the implementation of renewable energy resources. This aligns with the work of other researchers who engage with rural communities. Uhsrud et al. (2011) state that "the most common ways of using solar energy for electricity supply in remote areas are solar systems and solar lanterns...for homes and buildings without grid-connection".

The first project undertaken in the rural village was the installation of a solar powered borehole pump, replacing the existing diesel pump and resulting in a consistent water supply. A pipeline with multiple taps was also installed which provided the villagers with access to clean drinking water closer to their dwellings. The consistent, easy access to water provided villagers not only with sufficient water for cooking and cleaning, but also with an easy method of watering their subsistence gardens located near their dwellings via hose pipes from the communal taps. This motivated and enabled more of the villagers to plant gardens of fruit and vegetables for own consumption. Figure 2 indicates the layout of the water system.

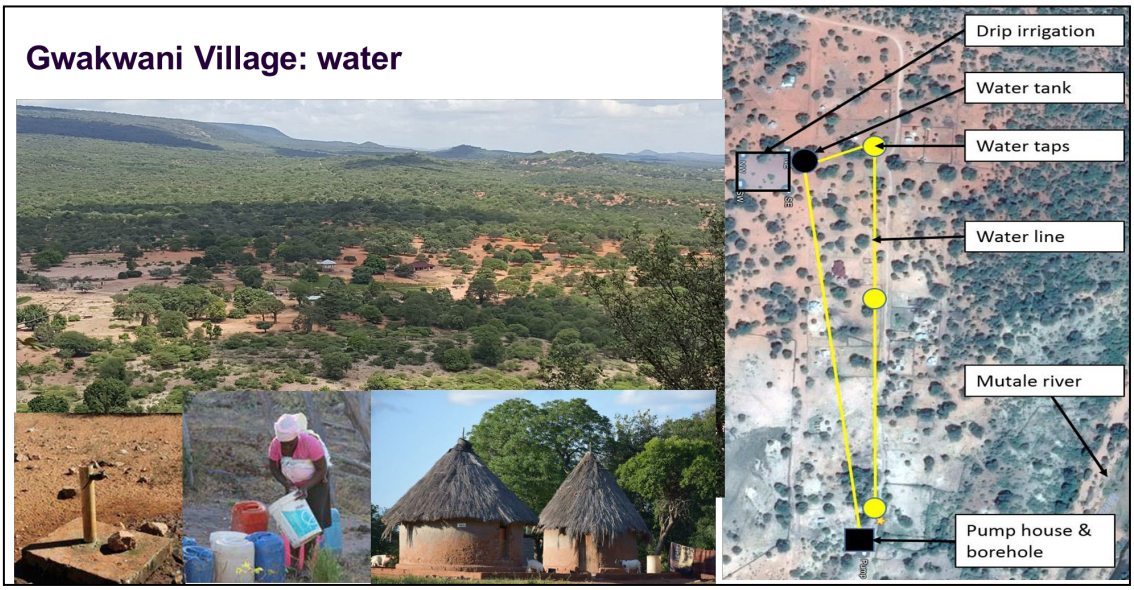

Figure 2. Water system lay-out

After alleviating the intermittent water supply, villagers expressed their need for light in their dwellings as well as a local cell-phone charging point. The project team engaged with industry and obtained co-operative sponsorship for solar residential lighting equipment which was installed in the villagers' dwellings which provided light at night, as well as the ability to charge cellular devices. In addition to the small solar powered lights installed, a solar powered streetlight was also centrally installed. The provision of the solar powered cellular phone charging point in their dwellings removed the need for community members to travel to the neighboring village to charge their phones. Figure 3 provides images of the photovoltaic borehole pump and the provision of lighting to the villagers.

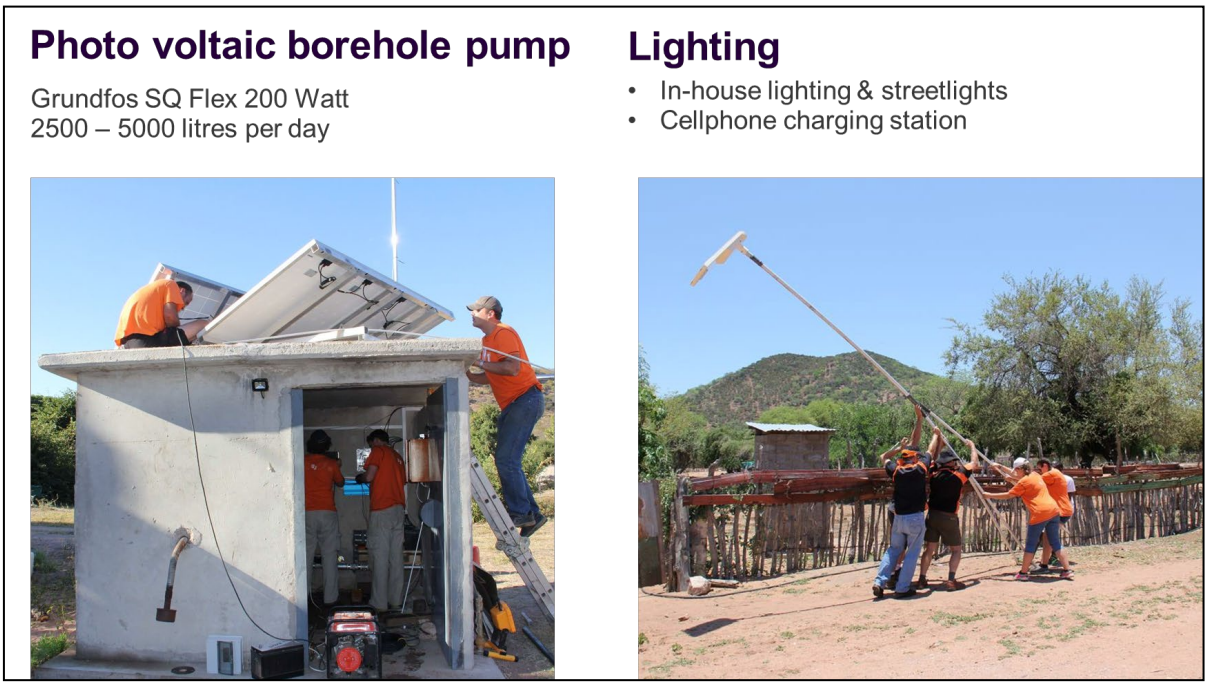

Figure 3. Photo voltaic borehole pump and lighting

As more families started to plant fruit and vegetables on small scale next to their dwellings, the community expressed the need for a method where agricultural farming can be conducted more efficiently with economic growth potential. Commercial entities close to the Gwakwani community expressed a need for certain fruit and vegetables, which presented the opportunity of economic growth. Consequently, a drip irrigation farm was designed and co-operatively established by the community and the project team. Figure 4 shows a few of the products of the drip irrigation plot.

Figure 4. Drip irrigation plot

In a bid to further support the economic development of the community, the project team obtained corporate sponsorship for a containerized bread bakery. The supply of the bakery included training of community members to produce fresh bread for the community members as well as create a business from the sales of additional bread. The bakery required electricity power supplied from the utility grid, which was unfeasible in this environment. This challenge required the project team to conceptualize, design and implement an off-grid solar powered solution to power the bakery. Images of the solar powered bakery are presented in Figure 5.

Figure 5. Solar powered bakery

Additional needs expressed by the community included a crèche, an adult education center, and a cold storage facility for produce. The projects continued to grow as the needs of the community changed. The additional requirements from the village members are not unusual in rural community engagement, as similarly experienced by the case of Mawengi in Tanzania, where the energy program was also coupled with complementary activities such as education and agricultural processing (Ahlborg and Sjöstedt 2015). This continual evolving of the system with new external demands demonstrates a key aspect of socio-technical systems, namely that such systems are open, dynamic, and flexible. Figure 6 shows images of the Gwakwani Village crèche.

Figure 6. Gwankwani Village crèche

Uhsrud et al. (2011) state that several aspects of solar installations in small communities warrant consideration for sustainability, including "repair and maintenance, finance, impact on people, accessibility and affordability". The impact of the technology on the villagers is clear from the foregoing discussion: as their basic need for constant and safe water supply was met, further requirements towards self-sustenance were identified and

voiced. An interesting and constant challenge faced by the project team includes the fit-for-purpose assessment of equipment obtained from corporate industrial sponsors. In many cases, the sponsored equipment is not ideally suited for a rural environment; and creative thinking is required from the project team to solve these unique challenges as they consider the needs of the community as well as the corporate sponsor who funded the project.

The other aspects such as accessibility and affordability, and maintenance and repair, require significant consideration. Maintenance and repair are still addressed by a project team member having to drive to the village and conduct the necessary work, which demands two to three days' time from the team member. This remains an uneconomical and unviable solution and the project team is currently investigating alternate equipment with longer lifespans through cost-benefit analysis and consideration of accessibility and affordability.

4.2 Financial Considerations

Funding of the equipment, labour and installed maintenance for the project was sourced from a corporate sponsor. Several authors state that funding and the management thereof are two of the key barriers to success in community engagement projects (Uhsrud et al. 2015; Uhsrud et al. 2011; Ahlborg and Sjöstedt 2015; Schöttl and Lindemann 2015; Clegg 2000). The project team manages the corporate sponsor / university relationship, as well as the effective and appropriate distribution of the funds. The team must ensure that the funds are disbursed across the full project lifecycle, from inception to support and maintenance; always being cognizant of the requirements of all the stakeholders of the project as well as the dynamic changes in the system. Furthermore, the fiduciary responsibility of the fund allocation rests with the project team leader and ultimately the University; and the fund accounts are professionally audited as per University regulations. Sourcing and management of funds from industry or research grants require skill and experience; and a key success factor of community engagement projects is the appointment of people with the requisite skill to the project team.

4.3 Social Considerations

The project enabled the project team and researchers to delineate the social construct of the socio-technical system. Elements that characterized the social aspect of the project were cultural differences, language barriers, lack of communication channels, and geographical separation - all elements with the potential to contribute to a misunderstanding of the needs of the community and consequent disengagement from the project by them.

The project team is from an urban university, and they needed to determine how they could effectively engage with the rural community to design solutions for the identified problems. As outsiders, it is often difficult to identify the priorities of the locals and to understand the best way in which it can be met, especially when faced with language and cultural barriers (Montgomery 2009). To address the language barrier, all communication took place via interpreters who could understand both the native language (Venda) and English. Cultural communication methods were introduced to the project team from team members who were familiar with the cultural communication methods employed in the community.

One of the main requirements for effective and sustainable community engagement projects relies on social buy-in (Uhsrud et al. 2011; Ahlborg and Sjöstedt 2015; Goldfields 2015; Alvial-Palavicino et al. 2011). Simply providing the community with equipment or technology without engaging with the community on their needs and the maintenance of the equipment, will leave the community in a worse state than before the intervention. It is imperative to include the community in all aspects of planning, decision making and implementation of the proposed solutions. The project team's view of an appropriate technology solution might not be the best for the community. As a result, a thorough needs assessment was conducted to ensure that the correct technology or solution was provided for the community (Naidoo and Meyer 2017).

4.4 Environmental Considerations

Appropriate resource management was a critical consideration by the project team to ensure that the resources consumed in the community do not have a long-term negative impact. One of the main foci in the village revolved around water provision. South Africa is a water scarce country, ranked the world's 30th driest country where water conservation and the efficient use of water are key national priorities (World Cup Legacy Report 2011). The technology solution, including water pipes, taps and irrigation systems, was designed and implemented with the dual purpose to provide water to the impoverished community and to conserve it.

5. Conclusion

The Gwakwani Project offered the University of Johannesburg the opportunity to engage in rural community development as a socio-technical system. The project promoted and developed critical and innovative thinking in the project team regarding the impact of their engineering activity. Through participation in real-world

projects and providing technical solutions which directly impact the people and the environment, the project team gained an "integrated perspective on society and technology, energy and development, and social transformation" (Uhsrud et al. 2011).

As previously discussed, key characteristics of a socio-technical system are that the system is mutable, flexible, and adaptive to change. The Gwakwani Project demonstrated these qualities in the dynamic interface between the social and technological factors, as well as the relationships amongst the University, project team, funders, and the community. The constant need for social, political, technical, and financial adjustments; as well as the new requirements expressed by the community, demands a continual learning process by the many actors and stakeholders in the system. These qualities of rural community engagement as a socio-technical design are confirmed by Uhsrud et al. (2015) in the following extract:

Another key result is that the socio-technical design should have sufficient flexibility, allowing for changes and improvements because demands and practices of use are often difficult to foresee and are shaped only during the use phase of a technology. Flexibility is also important in order to facilitate creativity and innovation by local actors. Organizations that fund or initiate such projects should be prepared for changes in the project even after implementation.

Working in a deeply rural community where resources are limited, the project team became aware of the social, environmental, and economic responsibility of using available resources appropriately. The intention of engagement with rural communities towards self-sustenance, however, is difficult to achieve. The remote geographical location of the village, the level of education of villagers, and the lack of constant and reliable electricity supply are factors that contribute to their reliance on external funding and government support. Ahlborg and Sjöstedt (2015) found similar challenges in providing small-scale hydropower in Tanzania: "The main lesson learned from this study, however, is that many of these challenges can be overcome: having a long time frame, acknowledging the challenges, and having the resources to restructure the program accordingly".

The value and contribution of the work presented in this paper lie in the application of the principles of socio-technical theory to a relatively new and unexplored system, namely rural community engagement. In a country as diverse and unique as South Africa, culture and language play a major role in effective communication between urban and rural actors; which may determine the success of the project in its entirety.

The intervention in the Gwakwani Village was initiated as a small-scale University project, but continues to grow in its' impact and learning as new requirements are expressed by the village members. Uhsrud et al. (2011) predict that "Such small experiments constitute important pioneering activities in order to create new socio-technical systems that sometime may achieve a significant role in society". This is certainly a reflection of the Gwakwani Project, where companies and government agencies are starting to show interest in funding and promoting similar projects across the country, realizing perhaps the most fundamental aim of rural community engagement – to alleviate our fellow countrymen and women of deep poverty.

References

Ahlborg, H. and Sjöstedt, M., Small-scale hydropower in Africa: Socio-technical designs for renewable energy in Tanzanian villages, *Energy Research & Social Science*, vol. 5, pp. 20-33, 2015.

Alvial-Palavicino, C., Garrido-Echeverría, N., Jiménez-Estévez, G., Reyes, L. and Palma-Behnke, R., A methodology for community engagement in the introduction of renewable based smart microgrid, *Energy for Sustainable Development*, vol. 15, pp. 314-323, 2011.

Brydon-Miller, M. and Greenwood, D., *Action Research*. SAGE Publications, London, 2003.

Clegg, C.W., Sociotechnical principles for system design, *Applied Ergonomics*, vol. 31, pp. 463-477, 2000.

Davis, M., Challenger, R., Jayewardene, D.N.W. and Clegg, C.W., Advancing socio-technical systems thinking: A call for bravery, *Applied Ergonomics*, vol. 45, pp. 171-180, 2014.

Department of Education, *Education White Paper 3: A Programme for the Transformation of Higher Education*, Available online: http://www.che.ac.za/media_and_publications/legislation/education-white-paper-3-programme-transformation-higher-education. 1997.

Goldfields. *Community Relations and Stakeholder Engagement Handbook: Summary*. Available online: https://www.goldfields.co.za/pdf/handbook/community-relations-09052016.pdf. 2015.

Maguire, M., Socio-technical systems and interaction design-21st century relevance, *Applied Ergonomics*, vol. 45, pp. 162-170, 2014.

Montgomery, M.A., Bartram, J. and Elimelech, M., Increasing Functional Sustainability of Water and Sanitation Supplies in Rural Sub-Saharan Africa, *Environmental Engineering Science*, vol. 26, issue 5, pp. 1017-1023, 2009.

Naidoo, R. and Meyer, J., Impact assessment to measure the success of implementation of rural community engagement projects. A case study. *IEEE Africon*, 2017.

Nel, H., Managing Socio-Technical Projects in Higher Education, *Projects as Socio-Technical Systems in Engineering Education,* CRC Press, 2018.

Nepal, T. and Petkov, D. An Action Research Oriented Systemic Framework for the Evaluation of Rural Telecommunications Infrastructure, *Proceedings of the 11th ANZSYS / Managing the Complex V Conference*, 5 – 7 December, 2005.

Reason,P. and Bradbury, H., *Handbook of action research: Participative inquiry and practice*. Sage Publications, London, 2001.

Schöttl, F. and Lindemann, U. Quantifying the Complexity of Socio-Technical Systems – A Generic, Interdisciplinary Approach, *Procedia Computer Science*, vol. 44, pp. 1-10, 2015.

South African Council on Higher Education: The Kagisano Series. *Community Engagement in South African Higher Education*, 2010.

Uhsrud, K., Winther, T., Palit, D. and Rohracher, H., Village-level solar power in Africa: Accelerating access to electricity services through a socio-technical design in Kenya, Energy *Research & Social Sciences*, vol. 5, pp. 34-44, 2015.

Uhsrud, K., Winther, T., Palit, D., Rohracher, H. and Sandgren, J., The Solar Transitions research on solar mini-grids in India: Learning from local cases of innovative socio-technical systems, *Energy for Sustainable Development*, vol. 15, issue 3, pp. 293-303, 2011.

UN Documents (1987). Report of the World Commission on Environment and Development: Our Common Future. *Development and International Co-operation: Environment*. Available at http://www.un-documents.net/our-common-future.pdf

United Nations (1955). *Social Progress through Community Engagement*. New York: United Nations.

World Cup Legacy Report (2011). *Water*. Available online: https://www.environment.gov.za/sites/default/files/docs/water.pdf

Biographies

Professor Suné von Solms is an Associate Professor and Head of Department at the Faculty of Engineering and the Built Environment at the University of Johannesburg, South Africa. She obtained a Ph.D in Computer Engineering, is a registered professional engineer with the Engineering Council of South Africa (ECSA) and a National Research Foundation (NRF) rated researcher. Her research interests include networks and communication, engineering education, the social and human aspects of engineering and cybersecurity. She is actively involved in engineering and community engagement projects within rural communities. Suné is also involved in research relating to cybersecurity-related skills and competency development of engineers.

Professor Hannelie Nel is a Visiting Associate Professor of Practice with the Postgraduate School of Engineering Management at the University of Johannesburg; and a Professional Engineer with twenty five years' experience in both academia and industry. She is the Regional Assurance Manager for Worley Middle East (United Arab Emirates, Egypt, Iraq and Oman) and based in Abu Dhabi. She holds a Doctorate in Engineering Management, a Master of Science Degree in Industrial Engineering and a Bachelor's degree in Chemical Engineering. Her research interests and work include process improvement, quality and risk management, and costing of industrial systems.