Researching Research in Development Engineering

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Abstract

This short paper introduces some of the issues that need to be considered when researching and presenting topics relating to water and sanitation in low-income countries. It raises some common problems and provides guidance for students considering carrying out work in this area.

Introduction

The need for basic infrastructure in low and middle-income countries, such as water and sanitation services, is an obvious, pressing and a real problem. Recognized constraints are lack of qualified and experienced staff, poor funding arrangements and inappropriate technical solutions. Appropriate technologies have been recognized as essential for over 30 years and initially, there were some successful innovations, such as the Ventilated Improved Pit Latrine and India Mark II hand pump. This was coupled with social techniques such as Participative Rural/Rapid Appraisal (PRA) and Participative Hygiene and Social Transformation (PHAST) that engaged with the community, addressing their needs and demands. These approaches provided an alternative to the more complex designs being used in industrialized nations. However, these only met one need but there is a whole spectrum of conditions that also need to be addressed. In particular, there are gaps at both the most basic, rural household level and for small towns and peri-urban areas.

For the most basic services, the Rural Water Supply Network (RWSN) has started looking at options for people who would not be able to afford and maintain a simple hand pump. On the sanitation side, Community-Led Total Sanitation (CLTS) is showing early promise. In urban areas, recent work has focussed on looking at management systems rather than technical solutions. The change in performance of utilities such as the Uganda National Water and Sewerage Corporation (NWSC) in the space of a few years has demonstrated how a professional approach to service provision can be dramatic.

The dire need for service provision calls for current approaches to be continually improved, technically, managerially and socially. Much of this can be achieved through better training and awareness of existing knowledge, but gaps in that knowledge still exist and require research.

What is research?

Engineers are used to solving problems. Consultants and contractors have to be innovative to succeed in their work. However, this is usually in areas where there is (normally) a solution and the search is for the best one out of a range of options. Research goes beyond straightforward design, moving to the frontier of current knowledge, where there may or may not be a solution. In research the answer may be “no” (i.e. this cannot be done, this does not work) and this is just as valid as a “yes” (i.e. this technique works in this particular context). Knowing what does not work or does not exist is important as it allows subsequent work to move in another direction. Repeating work is wasteful so being able to give the results of one line of enquiry is good whatever the outcome. The outcome of research is unknown at the start of the project – if it was known it would not be research. A good example of this is proving an hypothesis (or not).
Process not just product

Whilst the outcome of the research is of primary interest, it has to rest on solid foundations. Stating that something does not work may be due to poor investigation and not the problem of the issue under study. This could rule out options unnecessarily that do have potential. Similarly, the method of investigation has to be well recorded; this ensures that the work could be repeated in another location and the two cases compared. How research is carried out is important and the validity of the results depends on it. Managing research is different from project management where the steps and outcomes are more certain.

Researching development engineering

In most branches of engineering, there is a long history of research and development. At undergraduate and a lesser extent postgraduate (Masters) level, many students will be covering areas that have been investigated previously to a greater or lesser extent, being often variations on a theme and the results are largely predictable. Development engineering however is a very small sub-sector of engineering and so students researching in this area can be at the forefront of knowledge. This makes the research valuable. This is not to say that research has not been carried out however; one of the common problems with poor quality research is lack of initial investigation and subsequently re-inventing the wheel.

Research is not design and construction; research projects are not implementation projects unless they are designed to be “action research” (considered below) but this is a difficult option, as the researcher has to balance research objectives with practical concerns. Digging a well is not research – it has been done before. However developing a new well digging technique and trialling it would be research.

Development engineering is an applied subject, based in the “real world” and this brings complications. It is generally accepted that engineering cannot be carried out in isolation but is only one aspect of providing infrastructure services. The subject is by its very nature an integrated, holistic area and so social, economic, human and environmental factors will impact on and be impacted by the development of physical infrastructure.

Choosing a subject

As work in development engineering research has been going on for many years, it is worth consulting with experienced professionals in the area for suggestions for topics. This reduces the chance of repeating work that has already been carried out or taking on too large a project. Ideally a number of projects should be short-listed or a broad topic initially reviewed that can be focussed down later. It is important for the researcher to make the final choice on the subject. This is for three reasons:

- The topic has to interest the researcher; the student has to work alone on the project and strong self-motivation is vital. The enthusiasm has to last the duration of the project and this will be based on personal preference.
- The topic has to relate to the wider interests of the researcher. For students, the goal is not just the increase in knowledge but also gaining relevant experience for their career. In choosing a project, the student should consider their medium and long-term goals, not just the task of getting through a thesis. There is plenty of scope for focusing on particular aspects, such as construction, design or management that can provide a degree of specialization that may be useful in a competitive job market.
- The topic has to be achievable; a specific interest in one area may not be valid with restricted time and resources. Often the researcher has to be opportunistic and “piggy-back” on other projects. Many commercial and non-governmental organizations may be happy to provide a certain, limited level of help, but it should be borne in mind that this is not their main area of work and they may not have the interests, skills or resources to support student projects. Masters students should have more to offer than undergraduates can potentially provide. Whilst the researcher may want to solve all the problems they encounter, they should be realistic in what can be carried out.

Methodology

Part of engineering academic training is experience of laboratory experiments; these provide a good grounding in the science of hydraulics, materials or structures. This is only one technique of investigation and only relates to certain problems. Experiments work by isolating different variables and changing one (or more) variable at a time to observe the impact this has. In development engineering a wider range of techniques are employed as the inherent holistic nature of the subject means that many variables cannot be controlled in the same manner as a traditional experimental approach. Some of these alternative approaches have been developed by other academic disciplines such as geography and social science and more information will be found in textbooks relating to those areas rather than mainstream engineering. Research techniques include:

- Case studies (examining a particular project or location, recognising its specific context but trying to extrapolate to a wider scale);
- Action research (using a live project as a case study, observing from the “inside”);
- Desk studies (using written sources (published and “grey”) to investigate a topic remotely);
Literature review or situation report

Whatever research technique is being used, the state of existing knowledge has to be ascertained. Research is about investigating new issues and not repeating what is already known. This might seem like going over old ground but it is a vital element of research. It could be that work has been carried out in the particular area under investigation but has not been published which makes unearthing it more difficult. Again, expert guidance can be valuable here. For action research where the focus is more practical, this is often termed a “situation report” and looks at the context and history of the project as well as the more generic research background.

Finding literature is a skill that is developed more in social sciences than in engineering. It involves discovering what has been written about a subject and subsequently analysing it to see what is generally accepted, what gaps and omissions exist and what is disputed. This establishes the frontier of current knowledge and provides a platform for the research.

Literature search

Sources of knowledge are traditionally academic journals such as those published by the Institution of Civil Engineers. Whilst this is straightforward for many academic subjects, this is not so easy for development engineering, for the following reasons:

- The multidisciplinary nature of the discipline means that work is published in a wide range of journals;
- The applied and practical nature of the discipline means that work is often published as internal government or NGO reports, which are less available and not peer reviewed;
- The character of practising engineers means that they like to “do” rather than write about what they have done. This is especially true for engineers working in emergencies when time constraints are acute;
- Many engineers are working or living in low-income countries where publishing journals is difficult for cost and practical reasons; and
- There are numerous introductory books and briefing notes giving an overview of many subjects, often repeating similar ideas; this “noise” can crowd out more authoritative, in depth information.

The internet is both useful and confusing. Time needs to be spent, with careful selection of keywords to find out what is on-line, but many older reports are not so readily available. Journal databases are very powerful tools that search across many academic papers; university librarians are a good source of help in searching for information. Keywords need to be selected with care as there are often many synonyms (e.g. low-income countries*, developing countries*, third world, majority world, the south, least developed state*).

There are specialist terms and sectoral jargon that a beginner in the field may not be aware of. Specialist libraries do exist and can be a very valuable source of information.

Risks, ethics, and practicalities

Field research, especially working with local communities, brings complexities that are not encountered in laboratory research. Whatever research is being carried out, a risk assessment will need to be carried out. Overseas research brings incidental risks such as travel, health concerns and a higher level of uncertainty that are not directly connected to the research itself. Carrying out a water quality analysis in a UK lab or a Zambian refugee camp will have the same specific hazards. However, the contexts vary a lot and the consequences of any accidents are significantly different so a more cautious approach to risk is necessary in unstable or remote locations.

One risk that needs to be considered is the affect on those who are “researched”. Working with communities can have both positive and negative impacts on local people. Ethical concerns need to be considered – people cannot be “experimented” upon unless rigorous procedures are followed and their informed consent is gained.

Logistics and practical considerations like travel, arranging meetings, making contacts and general organization take time, so research activities can be slower than planned, with greater levels of uncertainty. Rates of progress can be markedly slower than similar work in the UK. This means that planning and recording progress are useful tools to help manage the research project. Parallel rather than sequential activities enable flexibility within the programme.
Analysis

Engineers will be familiar with numerical analysis and the use of computers to see patterns in data. Again, a multidisciplinary approach requires a range of analytical tools to understand what is occurring. A recent MSc student had to use institutional assessment methods such as organograms and STEP (Strengths, Weaknesses, Opportunities, Threats) to observe the problems with water quality control in a large government scheme; in another water quality project, a student spent more time looking at legislation than in the lab. Data will be qualitative as well as quantitative and the analysis will need to reflect this.

Dissemination

One important aspect of research in this sector is dissemination – letting other people know the results of your work. It is good manners to share your findings with those people you have been working with, such as NGOs and any communities that you have worked with. The wider research community may also be interested to learn about your findings at conferences (either as a paper or as a poster). Because of the practical nature of this sector, papers at relevant conferences have merit if they are based on field experience, enabling relevant contributions to knowledge to be made by new researchers.

Managing your supervisor

It should be remembered that the research student is the prime motivator for carrying out the work; this is a change for undergraduates as normally coursework at this level is very directed, with limited need for (time) planning. The research supervisor can provide advice and comment but will have other priorities. Having a clear programme of work and regular supervision meetings makes this relationship easier to manage. As with any expert, supervisors have strengths and weaknesses. Overseas work and research in low-income countries’ infrastructure is a specialist area and the supervisor may not have experience in this field, especially some of the multi-disciplinary aspects, so involving your supervisor throughout the research process will help them understand the area you are exploring. It is worth repeating that research pushes the frontiers of knowledge (albeit slowly in some cases) and any supervisor, no matter how experienced, will be learning from their research student.

Conclusions

Researching the areas of development engineering can contribute significantly to the lives and livelihoods of people living in low-income countries. However, just like appropriate technology, the technology may be simple but the problems are complex; a professional approach should be taken to ensure the validity of the research and to maximise impact.

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