Social Aspects of Engineering Research and Practice

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Abstract

Engineers play an important role in society as the planners, designers and builders of infrastructure services. This role involves important decisions related to sustainability, financing and aftercare. As the global need for infrastructure services is still unmet and standards are changing with time, engineers' role will remain important in future. They will be expected to contribute to the robust, safe and appropriate infrastructure and reliable services. There is also an increasing demand on engineering practice to understand and integrate the social dimension into the planning, design and use of infrastructure. As members of multidisciplinary teams they are expected to work more closely with users and communities and in some cases learn from them, not only about their needs but also about the possible ways of facilitating what they want to achieve. In this context, engineers are expected to contribute to the social outcomes of their provisions i.e. the developments which people would like to see from the provision.

The engineering profession is expected to work more closely with other disciplines, to make sure that various social and technical aspects are well integrated. Often engineering practice is blamed as more biased towards physical infrastructure services which are only designed to serve the industrial sector or high income groups. This may undermine the value of engineering profession for all groups of society. Based on the author's 23 years of experience, this paper highlights some of these issues as personal reflections. It suggests that, although the physical components of infrastructure services will remain an important expectation from engineering, without understanding the people and their social processes, the desired social outcomes of engineering research and practice may not be delivered effectively. Using three examples, this paper describes the links between physical infrastructure, people, their processes and how those provisions are expected to achieve wider outcomes for people, such as income, employment, better health and self respect. We are also learning that the failure to understand social processes is a more common cause of infrastructure failure, in terms of its use and outcomes as compared to failure of the physical features. Though there is relatively little understanding available on how to avoid such failures in future.

At the end the paper asks a few questions, for example, to what extent is the engineering profession ready to take on this challenge? How much do they need to learn/un-learn within the profession? How much do they need to prepare to work with other professions? What skills will these interdisciplinary ways of working demand of the engineering profession?

Introduction

Engineering often deals with a number of inter-connected components; first and probably most common of them is 'physical infrastructure' in other words 'things'. These are mainly the physical components required for people to do certain activities to achieve certain goals. These activities and goals could be very different in different cultures. For example, a motorcar to travel a distance, a bridge to cross a river, a generator to produce electricity and an all weather walking track to attend a funeral, all serve this purpose. Around each of these physical infrastructure projects, there are important social processes, for example, from the design and manufacturing of a car, automobile engineers may be thinking and interacting with marketing, sales and safety experts and discussing impacts of various designs on drivers attitudes and perceptions. They may need to make changes to certain design features to incorporate the views of other specialists. The output of all this interaction, say a car, will meet the purpose of covering the distance but will also need to deliver this with safety, comfort and the price to attract willing buyers.

Let's take another example of social processes around waste recycling. The physical part may just be a bin and the data needed is about waste quantities, density, type and family members. This will help in deciding the size and material of the bin – the things side. The challenging part of engineering involves understanding attitudes, behaviours and reactions of people using this simple technology regularly, leading to a much larger outcome of recycling targets and resource conservation. The attitude to waste separation for recycling may vary with age, ethnicity, sex and other factors. In engineering research and practice, the available knowledge for the design of physical features is always available and is perhaps more researched than its relationship with the social processes and human behaviour. Therefore, the future cutting edge work in engineering will be on socio-technical aspects of engineering, where there is a vast amount to learn.

In certain areas of design and research, the human element is relatively low and the data and information could be reliably generated or already available. For example, if you are designing the foundation of a house, which will be below the ground, you may be thinking of its safety, robust design and durability. The required data is available and variations are predictable, using engineering software. While above the ground, design is a different game altogether, with a very dynamic changes happening continuously. Architects and engineers are working together, to develop the best possible design for the needs of the family, this may involve the use of space, aesthetics and many other features. This team work and interaction is not at all a surprise, because building construction is an established discipline, with large markets, known responsibilities, roles and expectations. While in subject areas where specialized disciplines are not yet developed, engineers are expected to multi-task, especially if a team is not in place. For example, a sanitation engineer working for a slum area in a low income country will not only be working on the design, but also working on costing, user charges, institutional aspects, hygiene behaviour and other social attitudes. In such cases, the ability of engineers to work on social aspects is of greater importance than their ability to work with a team of experts.

From the above discussion, it is important to conclude that engineers need to have a good understanding of social processes, to engage with a team of experts or in some cases to handle social and technical tasks on their own.

As the needs and expectations of society continue to increase, engineering discipline has also divided into design engineering, material engineering, safety engineering, environmental engineering etc. From mid 1960 specialized management fields such as construction management, asset management and infrastructure planning were also mainstreamed with conventional engineering. As standards and legislation improved, new courses were introduced, job titles changed and licensing needs also modified. The scope of the engineering profession continued to widen with time and so do the expectations. Specialisation, provides deeper knowledge on certain topics and at the same time it raises the expectations for more cross-disciplinary understanding.

Recognising these needs and greater concern about the environment, in the last 10 years sustainable development was pretty much mainstreamed into engineering practice and research. This has connected a number of aspects of engineering to wider development. Universities were funded to initiate cross faculty and multidisciplinary work. Open space planning was encouraged to break professional and ego barriers. Engineers were encouraged to think about the impact of their plans and construction on the environment, economy and society. A lot of this thinking was new and different, with longer time horizons and wider perspective. New concepts, such as life cycle and value chains, were introduced. According to the American Society of Civil Engineers (ASCE), vision 2025, 'Civil engineers are entrusted by society to create a sustainable world and to enhance the global quality of life. Civil engineers have a responsibility to develop clear statements of purpose and to analyze the costs, benefits and impacts of proposed actions, thereby assisting the general public in making more informed decisions about technical and engineered projects.'

Most of this connected thinking will remain important for engineers and they will continue to play a positive role in society. Engineers' training, prepares them to deal with physical things, while their practice enhanced the ability to work and learn from each other. Generally, graduate engineers are more comfortable with materials, designs, repair and maintenance of physical infrastructure. While, within the context of sustainable development, social sustainability is one of the five key bottom lines. Social processes by their nature are dynamic and change with the context. They are un-certain and un-known. Within the broad definition of sustainable development, social sustainability means reducing any adverse impact of physical infrastructures on societies, ensuring sustained social outcomes and the sustainability of social processes. This also means linking a number of social outcomes with the planning and design of infrastructure services.

Engineering research and practice need information to develop new designs and approaches. In many cases accurate data can be generated, which could lead to reliable predictions, as mentioned before. Though this data and information needs constant updating, it also needs newer analyses. It is known that engineering research needs information, but when it comes to social processes, which involve attitudes, behaviours and sometimes emotions and feelings, the information is highly difficult to predict. This information is about users, their groups and interaction within the group, with other groups and their capability to respond to external changes. Through three examples, I will try to explain the importance of learning to work with a high level of uncertainty in this area, as common in many research.

1) Solid waste management

In technical terms proper solid waste management is the storage, collection, transportation and final disposal of materials, by its first owner. By definition, engineers researching on the system, must be able to develop an effective system, so the generated waste reaches its final destination at an affordable cost and without causing any environmental impact. A typical design involves, sizing of facilities, their links as a system and details of it's operation. Specifications and good costing are usually final stages in the engineering design. In many developing countries solid waste systems are much more complex than a design and planning problem. There are extensive informal activities in the system, in fact the whole system of collection and recycling is dominated by the informal sector in many cities and towns. Thousands of waste collectors, small waste enterprises and waste pickers not only provide a service, but also earn their livelihoods. When I started research on waste systems in 1992, it was very obvious, very soon that the conventional research approach of sampling and questionnaire are neither necessary nor useful, even to answer some simple questions, such as how many waste pickers operate in a town and how much waste they separate for recycling. Simple engineering designs were constrained by external factors. We proposed a private waste collection in an area and later found that this was already, privatised at the grass roots level by sweepers. These sweepers had been providing a collection service for households to the municipal containers and charging a regular fee for many years. While residents were happy with the charges and service provision by the sweepers, they were reluctant to pay any money to the municipal governments, because of lack of trust and suspicion of corruption. Many recycling, schemes designed by engineers and implemented by government and private sector, failed to provide any results, because households and waste pickers were already separating all the valuable waste during the collection stages. We found complex relationships between different groups of households, sweepers and pickers. There were mutual support systems, exploitation, power hierarchies and social controls. All this was extremely important to understand, before we designed and developed improved systems of solid waste, which is expected to sustain and deliver the desired outcomes.

2) Community Lead Total Sanitation (CLTS)

Last year (2008) was declared as the International Year of Sanitation. More than 2.5 billion people lack safe sanitation and as a result have 1.8 million deaths (WHO, 2004) from diarrhoeal diseases and cholera. Sanitation was declared a big challenge in international development. Initially toilets were thought a simple human need, which does not need rocket science as far as technologies are concerned. Later, many NGOs and international agencies, found that sanitation is not about building toilets. It needs a change in behaviour, habits, demand, hygiene education, continuous reinforcement and much more. Children and women were worst affected by poor sanitation. Young girls stopped going to school because of the lack of toilets needed during their menstrual cycle and children were scared of using toilets designed for adults. Even in technology, the cost of construction, affordability and standards were some of the major challenges, which required social research. To achieve positive health impacts, the whole area needs to have toilets and people must use them regularly. This means working at the village and neighbourhood levels, not just with households. In early 1990, some NGOs in Bangladesh and India, worked on an approach called the CLTS approach (CLTS, 2008). CLTS methods were developed to talk about 'shit' and create a feeling of disgust and shame among groups, such as villagers. The roots of CLTS are in Participatory Approaches (Chambers, 2008), already tested and successful. CLTS acted as a trigger and the whole village took the responsibility of constructing toilets and declaring the village as Open Defecation Free (ODF). This was a major social breakthrough to solve a problem, which had previously been considered as a health and engineering problem. The outcome of total sanitation was achieved, through the understanding and facilitation of social processes only. The next challenge is to enable social scientists and engineers to work together, to integrate the software and hardware of the CLTS approach to move to the next rung in the ladder.

3) Building with better designs and local materials

Building construction and materials have always been an important component of the work of Practical Action. It was felt that building materials and better construction techniques could make a significant contribution to the safety and quality of living space. These technologies could be researched and then further adapted with people on the ground. Support to construct the 'demonstration houses' plus further training in marketing, better financial management and access to loans could establish local enterprises, which would gradually flourish and ultimately large number of units would be constructed adopting the new building materials. Once, enough evidence is generated, we will do the policy advocacy and international influencing for a wider up-take. With time and especially as our work moved more in urban areas, we also found that regulations needs to be favourable to the technologies and working with powerful players is also important. So, our work also focused on these aspects. However, after doing all this, we found that scaling up was not taking place as expected. Our supported groups were not becoming independent and self replicating, as initially thought and people were not adopting technologies by just observing the demonstration. There were clear indications of un-certainty and even in some cases, demonstration houses were seen as assets controlled by certain groups and divided the community. Some evaluators questioned our approach, as too expensive and slow to reach large numbers. Politicians paid more attention to borrowing money and building a large number of houses. We soon recognized that housing is much more than introducing materials, technologies, training and loans. There are a number of deeper social processes attached, which need to be understood. We found that the design and materials of houses are very much a personal choice, while the community groups and enterprises operate in a system, which has a number of social and economic forces. There were serious divisions to control and achieving powers within the community. Based on all this learning, our approach has changed, with local community groups given support to innovate and experiment and us deciding to systematically learn and share. In our approach to owner-driven reconstruction, post-tsunami people have a wider choice of land, type of housing and construction methods and now we are working more with systems and drivers of change, rather than with individuals or small groups.

Conclusions and Learning Points

In summary, there are three important points to consider:

Engineers' role will remain important in society, while engineering practice and research need to have a better understanding of the social processes which have a sustainable impact on their physical infrastructure. This involves building some basic skills within the profession but also enhancing the ability to work across disciplines.

Engineering practice and research is always more concerned with the physical failures of infrastructure and poor financial viability of certain services. As apparently there are fewer physical failures and more failures related to social processes, most of the future, cutting edge work will be on socio-technical areas.

Engineers are increasingly entrusted with a role in sustainable international development. Since, a number of disciplines are still not specialised and jobs opportunities are less, engineers are expected to take a multi-tasking role.

Note: The views expressed in this paper are of the author and not of Practical Action or any other organisation.

References

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CLTS (2008), 'Community Lead Total Sanitation'. Most of the knowledge resources are being moved to its website, http://www.communityledtotalsanitation.org

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