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Social relevance of science and technology produced by science councils in South Africa: the case of the CSIR

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Social Relevance of Science and Technology Produced by Science Councils in South Africa: the Case of the CSIR

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A research report submitted to the Wits Business School in the University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Management in Innovation Studies

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ABSTRACT

Science councils in South Africa have a mandate to produce R&D that contributes to the improvement of the quality of life of the South African population through science and technology (S&T). However, science councils seem to respond to the demands of the funders at the expense of user needs and priorities.

The purpose of this study is to explore the extent to which S&T produced by science councils is relevant to social needs of users. Using the case study approach, the case of the CSIR Built Environment (BE) operating unit was selected for the study, with a specific focus on water provision projects. Data were collected from users of technology (individuals and focus groups), stakeholders in the communities, as well as the CSIR as an organisation. The study explores the implications of better integration of social dimensions into the study and practice of S&T. It is the researcher's view that what is needed is a conscious and determined reorientation of science, technology and innovation to tackle these societal problems.

The study, by focusing on social relevance makes a case that there is a need for greater attention on the political and even ideological content of S&T production activities and the interactions of science councils with users. This should include issues of power, control and ownership of resources, as well as governance of the S&T production process. Science councils are likely to improve the social relevance of the S&T they produce by increasing the consideration of the context and its implications when developing science and technology. Science councils are also likely to close the gap between the technology and the users.

Participatory approaches to development are recognized as inherently superior to technocratic ones. A case is made for user involvement in determining and shaping S&T in line with the participatory development approach which advocates that S&T must address the priorities of user needs in order to be socially relevant. The social relevance of S&T produced by science councils in South Africa based on the case of the CSIR BE unit water management project can be improved. Overall, there was an opportunity for the CSIR to improve the relevance of the S&T it produces by being more effective in managing its interactions with users and stakeholders.

DECLARATION

I declare that this dissertation is my own unaided work submitted in partial fulfilment of the requirements of the degree of Master of Management in Innovation Studies at the Wits Business School in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other University.

Lesego Lucretia Nkhumise
10 October 2014

DEDICATION

To my children Kamogelo and Orefile.

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GLOSSARY OF TERMS

1. **Innovation** is defined as the process of creation, exchange, evolution and application of knowledge to produce new goods, services or social arrangements that are experienced as beneficial by a community, a market, or society (Knowledge for African Development (KAD) Booklet). For the purpose of this study, it is new services that are experienced as beneficial by society.

2. **Science** is defined as a process of inquiry, a way of learning and knowing things about the world around us using logic, observation and theory of knowledge covering general truths or the operations of fundamental laws (van Rensburg et al. 2010).

3. In line with the Cambridge dictionary, **Social** means relating to society and living together in an organised way.

4. As defined by the Bureau of European Policy Advisers (2011), **Social innovation** refers to innovations that are social in both their ends and their means. Specifically, these are new ideas (products, services and models) that simultaneously meet social needs (more effectively than alternatives) and create new social relationships or collaborations. They are innovations that are not only good for society but also enhance society's capacity to act. For the purpose of this study, this will be referred to as *Innovation for social purpose.*

5. As defined in the Cambridge dictionary, **Society** means a large group of people who live together in an organised way, making decisions about how to do things and sharing the work that needs to be done. All the people in a town, city, and country or in several similar countries can be referred to as a society.

6. As defined by Hobday (2005), **Technology** as the 'social pool of the industrial arts', technology can be seen as a resource embodied not only in physical capital but also, more importantly, in human skills, institutions and social structures. In contrast with the static concept of production capacity, technology represents the capability to create and extend the existing pool of technological knowledge.

LIST OF ABBREVIATIONS

BE – Built Environment

BEPA - Bureau of European Policy Advisers

CSIR - Council for Scientific and Industrial Research

MTEF – Medium term expenditure framework

OECD – The organisation for economic co-operation and development

PD – Participatory development

PRA - Participatory rural appraisal

PRO - Public Research Organisations

R&D - Research and development

SET - Science, engineering and technology

S&T – Science and technology

UNDP - United Nations Development Programme

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CHAPTER 1: INTRODUCTION

This chapter presents the purpose of the study. The context of the study is also described alongside the delimitation of the study.

1.1. PURPOSE OF THE STUDY

The purpose of this study is to investigate the extent to which Science and Technology (S&T) produced by science councils in South Africa is socially relevant using as an empirical illustration a project undertaken by the CSIR Built Environment (BE) operating unit. The next section presents the context of the study.

1.2. CONTEXT OF THE STUDY

This research project was carried out in the context of a science council which is one of the Public Research Organisations (PROs) in South Africa. According to David and Metcalfe (2007) the term “public research organization” includes both specialized technology research organizations, and higher education institutions that engage in research and development and research training activities with substantial funding support from public and quasi-public (e.g. charitable and non-profit foundation) sources. Among the variety of PROs, the “science councils” in South Africa are the main focus of this study and in particular the Council for Scientific and Industrial Research (CSIR).

Government’s role in coordinating and providing external institutional support is crucial in the case of developing countries that lack other forms of coordinating agencies especially private entities. Research councils strive to make a contribution to the growth and development of the country’s economy, in the process their priorities include contributing towards social development and adding value into people’s lives. This is done in conjunction with different stakeholders that may even consult the research institutions for solutions in order to execute their strategies.

According to Pefile (2007), S&T institutions in developing countries operate with

limited financial resources for S&T and even less funding for technology and knowledge transfer. The socio-economic challenges experienced by developing countries put more pressure on S&T institutions, requiring them to effectively and efficiently address local social and economic development needs through the transfer and adoption of innovative science. To this end, a key responsibility of research institutions in developing countries is to make research outputs available for use by society and local industry. It is therefore critical that research institutions not only generate relevant research, but also transfer and diffuse research results in a way that maximizes relevance.

While all stakeholders acknowledge the value they all add in their relationships, there is a challenge in measuring the relevance of S&T. Stakeholders such as corporate and government departments, therefore consider S&T as an investment and they carefully want to calculate the risk involved in such an investment. Research councils can therefore experience a decline in the income they manage to raise as a result of constrained budget availability. Research councils need to generate income through their S&T work over and above the grants that they receive as a result of their national mandates. The parliamentary grant for the CSIR in particular was not increased for the 2010/2011 financial year. It is equally difficult to secure and/ or earn additional income as fewer agreements are signed for this work.

Investec (2005) argues that there is a direct relationship between investment into infrastructure and socio-economic growth and development. Sound, well performing infrastructure such as housing, access roads, health facilities, sanitation and water provision are important contributions to socio economic development. This has been emphasised by government in the past decade and significant investment has been made in new infrastructure and significant additional amounts are planned for the future as shown in the 2010 Medium Term Expenditure Framework (MTEF) and as discussed in the National Planning Commission Diagnostic report (2011).

However, many comunications suggest that the investments to date have not been sufficient to ensure a well-performing infrastructure that *supports* economic

growth, social development and poverty alleviation. According to Rust and Koen (2011), the South African Institute of Civil Engineers (SAICE) reported in their Infrastructure Report that serious problems are experienced with South African infrastructure particularly in the areas of access to health infrastructure, water infrastructure, sanitation, as well as secondary and tertiary roads. These problems are due to a number of factors including insufficient funding to manage, plan and maintain the infrastructure assets, and a shortage of skilled resources. South Africa is not unique in this regard. The Urban Land Institute and Ernest and Young (2013) reported that worldwide infrastructure is currently in a poor state and that generally inadequate investments are being made in the upgrading and maintenance of infrastructure assets.

Similar to cases of other countries that went through colonialism the situation in South Africa in terms of the character of the built environment (such as cities and towns) on account of, for instance, the apartheid legacy, reflects specific conditions in terms of climate, geographical location and geology, and the African heritage. This implies that there is a need to foster unique South African technological solutions to solve problems and address the needs of the South African society. In this regard, the infrastructure and the built environment are very different from consumer products such as cell phones, computers and cars that are readily transferable and/or purchasable from abroad.

1.3 PROBLEM STATEMENT

Science councils have a mandate to produce S&T that contributes to the improvement of the quality of life of the South African population which includes science and technology (S&T). Science councils however seem to respond to the demands of the funders at the expense of user needs and priorities.

1.3.1 RESEARCH QUESTION

The study seeks to explore the following research question:

To what extent is the science and technology produced by science councils relevant to social needs of community members and stakeholders?

1.4 SIGNIFICANCE OF THE STUDY

This study expands on the body of knowledge relevant to science councils in South Africa, Africa, and in the Global South more generally, with a particular focus on producing S&T that is socially relevant.

Science councils offer expert advice on innovation based on the research and development (R&D) of S&T. In this way, S&T is undertaken in order to benefit both those who undertake it and society in an uncertain future. These attributes create some challenges in terms of measurement and analysis of S&T (Hall 2002). The same goes for S&T, challenging organisations to strive towards impactful S&T in their production. The study expands the assessment of S&T beyond impact, focusing on its social relevance.

Social development takes place only with proper provision of basic amenities such as hospitals, schools and housing, together with infrastructure for water and sanitation, electricity supply amongst other things. The CSIR BE supports South Africa's competitive performance and the welfare of its people through the development of technological solutions and the generation of knowledge to develop an efficient and globally-competitive built environment system in urban and rural areas. This study explores the social relevance of the S&T produced by the CSIR and provides an opportunity to find out what could be done to improve and optimise the contribution to improving the quality of life of the people in South Africa.

According to the OECD (2011), socio-economic development challenges put pressure on S&T institutions making it more difficult to effectively address local and social economic developmental needs by transfering and adopting innovative science. These issues also establish the necessity to assess through a research study whether the S&T work carried out is actually relevant to the social needs of the people in South Africa. Such an alignment could drive the ability of science councils to make a positive relevance on the economic growth of the country in the long term.

Although government undertakes various initiatives to support and accelerate the rate of S&T by setting up institutions and programmes (including grants), by and large, there are still gaps that need urgent attention. Research institutions receive minimal grants from government which they have to use for S&T that contributes to national development. Early stage development funds can come from sources such as industry and companies that wish to explore new S&T, universities and other research institutions or government grants.

In South Africa research funding comes from two major sources, corporations (through S&T departments) and government (primarily carried out through universities, research councils, and specialized government agencies). Some small amounts of scientific research are carried out (or funded) by charitable foundations, especially in relation to developing cures for diseases such as cancer, malaria, TB and AIDS.

The study is relevant in that it will add to the body of knowledge on the issues of social relevance in producing S&T. This empirical study makes a contribution to improved understanding of the dynamics of innovation for social purposes, where science and technology outputs are directed at improving the lives of poor people, and the interventions are implemented under conditions of resource scarcity. It also raises important issues about the ways in which formal knowledge production organisations can link more effectively with intended beneficiaries and users in very different settings.

1.5 DELIMITATIONS OF THE STUDY

The research is subject to certain delimitations and these are as follows:

- This research was limited to science councils and did not include all the other Public Research Oraginsations in South Africa.
- It was further limited to studying the relevance of water provision projects that were implemented based on S&T produced by the CSIR Built Environment operating unit. It did not include any other projects.
- It was further limited to studying the relevance of water provision projects

that were implemented based on the S&T produced by the CSIR Built environment operating unit in the Amathole District Municipality, Cwebe Village and the Sekhukhune District Municipality, Dresden Village respectively. It did not include particpants from villages other than the two that were selected.

1.6 ASSUMPTIONS

It was assumed that science councils strive to produce S&T that is socially relevant.

- It was assumed that the respondents of the CSIR Built Environment operating unit were aware that it was important to produce S&T that is socially relevant and the benefits thereof.
- It was assumed that all relevant information would be communicated during the interview process and that no knowledge would be knowingly withheld for fear of negatively impacting the employment in the CSIR Built Environement operating unit. This was a reasonable assumption as anonymity was guaranteed and the study was aimed at finding ways to improve and optimise the levels of social relevance of S&T. The research is sensitive to complete and truthful communication of facts as they relate to questions asked.

1.7 STRUCTURE AND OUTLINE OF THE REPORT

This chapter gives a synopsis of the entire study. The rest of the research report is structured as follows:

Chapter 2: Provides a review of literature that is relevant to this study.

Chapter 3: Describes the research approach and methodology used for this study.

Chapter 4: Presents the data collected for the study.

Chapter 5: Presents the findings of the study through data analysis.

Chapter 6: Presents conclusions and recommendations of the study.

1.8 CONCLUSION

The researcher aimed to assess the extent to which S&T produced by CSIR, Built Environment Operating Unit is socially relevant and contributes to the improvement of quality of life of people in SA. This was done by exploring whether it addressed the needs of users and/ or stakeholders? The extent of user involvemnet in S&T programmes was the main focal point of the study.

CHAPTER 2: LITERATURE REVIEW

This chapter presents relevant literature that has been reviewed in relation to the study. This will be done by organising the discussion around five main themes, which emerged in the literature reviewed. These themes include *Power Dynamics, Project Funding, User Involvement, Overall Relevance,* as well as *Participatory Development.* Although the literature presents these themes in a variety of contexts, this review will primarily focus on their application to social relevance as a factor influencing the effectiveness of PROs.

2.1 SCIENCE AND TECHNOLOGY PROGRAMMES IN DEVELOPMENT

According to the Academic Press Dictionary of Science and Technology, science is the concerted human effort to understand, or to understand better, the history of the natural world and how the natural world works, with observable physical evidence as the basis of that understanding. A case is made that science is done through observation of natural phenomena, and/or through experimentation that tries to simulate natural processes under controlled conditions. Context therefore matters as the conditions in the natural environment as well as the philosopical understanding of various phenomena should be taken into account in science. Technology on the other hand is defined as the branch of knowledge that deals with the creation and use of technical means and their interrelation with life, society, and the environment, drawing upon such subjects as industrial arts, engineering, applied science, and pure science. It therefore requires for things to be taken a step further beyond pure science where technical means are created in their relation with life, society, and the environment.

According to the OECD (2000) scientific advances and technological change are important drivers of economic performance. The ability to create, distribute and exploit knowledge has become a major source of competitive advantage, wealth creation and improvements in the quality of life. These changes imply that science, technology and innovation are now key to improving economic performance and social well-being. The OECD policy brief cited above recognises basic scientific

research as the source of numerous technologies that transforms society.

Traditionally, innovation was thought to be a linear process beginning from research and development, then going into manufacturing and ending at marketing the product. This is referred to as the technology-push model. Also, a view of the process starting from marketing and then going through research and development to manufacturing and end users has been presented. This, on the other hand, is referred to as market-pull model. However, these models do not explain how innovation happens but they rather concentrate on what is innovation's point of initiation (Trott 2002: 17-18). Figure 1 presents the interactive model of innovation presented by Trott (2002: 19). The information flow is not necessarily linear and the market place and the science base interact with all functions including science and technology (S&T); and not just with R&D or marketing. Innovation can originate from any point in the model.

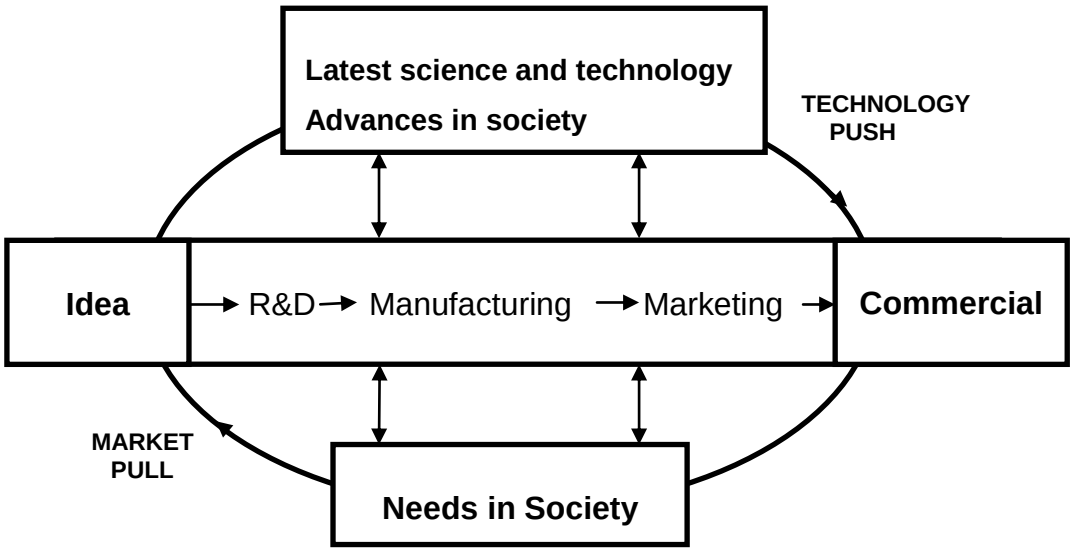


Figure 1: Interactive Model of innovation (Trott 2002:19)

According to research by a Brazilian scholar, Goldemberg (2003), developing countries should not expect to follow the research model that led to the scientific enterprise of the United States and elsewhere. He argues that rather, developing

countries need to adapt and develop technologies appropriate to their local circumstances. He further makes a case that scientific research is motivated not only by curiosity or love for science, but also by trends and the perception that some areas of research are more rewarding than others. He argues that it is important that developing countries avoid the allure of costly but ineffective programs and establish a system that rewards solving practical problems. Goldemberg argues that although that emphasis may seem to stray from the tradition of academic research, many seemingly mundane problems require very sophisticated tools and technologies; and science can accelerate progress. He makes a case that the transition of a country from developing to developed is a complex process that requires facing up to the established interests in society.

According to the OECD (2000) science and technology merge in the pursuit of knowledge and solutions to problems that require the application of scientific understanding and product design. Solving technological problems demands scientific knowledge while modern technologies make it possible to discover new scientific knowledge. Pinch and Bijker (1987) make a case that science and technology are interdependent and cannot be separated from each other. These scholars further argue that situations and people do influence “norms and values,” and help to construct meanings to things. In a world shaped by science and technology, how science and technology connect with the demands of society is very important.

Cassiolato, Soares, and Lastres (2008) argue that innovation can not be defined as a single act. This highlights the importance of the evolutionary view contribution that brought the understanding of innovation as a process by which technical novelty is developed and introduced in society. Stressing the significance of the systemic character of innovation - both in analytical and normative terms - the authors suggest the idea of socially oriented innovation as those processes that target the development of products and processes, technological and organizational that aim to meet a societal need.

According to the American Chemical Society (2013) science can lead to better understanding of new solutions to many of society’s problems including

environmental and health issues. A case is made that in order to achieve this, the best science should be available to, and used by government officials when making decisions. To achieve confidence in government decisions that depend upon science and technology, science must be considered in an open and responsible manner. Science and technology is believed to provide critical tools that help us address our national and global needs. This signifies that an open exchange of information and ideas is critical to scientific progress.

According to the United Nations System Task Team (2011) technological change, particularly in developing countries, is not only about innovating at the frontier, but also about adapting existing products and processes to achieve higher levels of productivity as applicable to their local contexts. A case is made that in this process, the ability of local firms and enterprises to access technological know-how is fundamental to shaping their ability to provide products and services, both of the kind that are essential to improve living standards, and that could also promote growth and competitiveness.

The United Nations Development Programme report (UNDP 2004) suggests that in order to address development issues in a holistic way, PROs need to ensure that actions taken in one area, such as sanitation, do not worsen conditions in another, such as the environment; this requires capacity for cross-sectoral planning and policy making, an ability lacking in many developing countries and many donor agencies, as well. The role and performance of public research organisations in science and technology will be discussed next.

2.2 THE ROLE AND PERFORMANCE OF PUBLIC RESEARCH ORGANISATIONS IN SCIENCE AND TECHNOLOGY

According to David and Metcalfe (2007) the term “public research organization” includes both specialized technology research organizations, and higher education institutions that engage in research and development and research training activities with substantial funding support from public and quasi-public (e.g. charitable and non-profit foundation) sources. Among the variety of PROs, the “science councils” in South Africa are the main focus of this study.

It is quite common for the mandate of S&T ministers and agencies to involve harnessing S&T in support of social and economic development of the respective nations (Holbrook 2009). S&T performers function within the specific context of a national social, cultural, political, financial and economic system, frequently carrying with them the legacies of colonial, post-colonial and other forms of governance. In developing countries it is government rather than the private sector that tends to dominate S&T and therefore it is important that PROs are effective (Kahn and Hounwanou 2008). This thinking however does not discount the role of the private sector in S&T production.

According to (Arora et al. 2001 as cited by von Nell and Lichtenthaler 2011), the development of S&T in the era of pre-industrial revolution involved the development of 'unified science' consisting of a balanced integration of philosophy, ethics, science, technology, sociology, economics and anthropology. This science was expected to lead the world towards sustainable development. Technology can take the form of intellectual property or intangibles, such as designs or software. Furthermore, it can be embodied in products or technical services. These scholars make a case that therefore, technological knowledge may be considered as an "imprecise term for useful knowledge rooted in engineering and scientific disciplines".

Technological knowledge is usually developed for a specific context and a specific use, and it partly has a tacit nature. Thus, transferring it to a different context or using it in a different way can involve major problems, leading to a lower efficiency and to relatively high transaction costs in technology. The development of science and technology thus needs to take into account the context and specific use for efficiency and sustainable development.

Historically, in innovation studies there has been more emphasis on "supply push" of new technology into the market (OECD 2002). While these factors play a role it does not account for the role of the firm as the diffusion agent for innovation. Contemporary studies of innovation systems are identifying strong "demand pull"

factors as influencers for innovation. In this approach consumers make their needs known via firms and new solutions (technologies) are produced through S&T. The extent to which there is demand driven innovation is largely dependent on the absorptive capacity of firms (their production and innovation capabilities and search for new technologies) (Schmidt and Druehl 2005).

A dynamic model of the innovation system therefore presents both the supply and demand drivers of innovation; whereas the OECD framework is limited to a linear aspect of supply side drivers (Cava-Ferreruela, 2004). If PROs are to deliver against the mandate to harness S&T to support social and economic development of the nation, they would need to take the “demand pull” approach to S&T activities into account. As part of background, the effectiveness of PROs will be looked into.

2.3 EFFECTIVENESS OF PUBLIC RESEARCH ORGANISATIONS

This section focuses on the effectiveness of PROs. According to OECD (2011) PROs come under close scrutiny because governments tend to keep a considerable degree of control over employment and funding. In the case of PROs that are strongly dependent on the state, the ease of establishing new goals is limited unless the state directly allocates new resources (Whitley 2010). Based on the above, while decisions are made to invest in specific projects, it is important to ensure that the approach takes both excellence and relevance into account.

Effective PROs display specific characteristics which include openness, being interdisciplinary, as well as responsiveness. Arnold, Barker and Slipersaeter (2010 p. 57) suggest the following as key features of research institutes:

- An adequate flow of competent researchers with high levels of mobility between institutions, disciplines, sectors and countries.
- World-class research infrastructures, integrated, networked and accessible to research teams nationally and internationally, notably thanks to new generations of electronic communication infrastructures.
- Excellent research institutions engaged in effective public-private

cooperation and partnerships, forming the core of research and innovation 'clusters' including 'virtual research communities', mostly specialised in interdisciplinary areas and attracting a critical mass of human and financial resources.

- Effective knowledge-sharing notably between public research and industry, as well as with the public at large.
- Well-coordinated research programmes and priorities, including a significant volume of jointly-programmed public research investment involving common priorities, coordinated implementation and joint evaluation.
- A broadening and opening up of the Research Areas to the world with special emphasis on neighbouring countries and a strong commitment to addressing global challenges with relevant partners.

Within his innovation typology, Brooks (1994) distinguishes between innovations that are almost purely technical (such as new materials), socio-technical innovations (such as transportation infrastructure) and innovations that are for social purposes. Social innovations in businesses, civil society, government and social milieus whose content relates to participation, procedural rules and behaviour as a special type of innovation to be distinguished from technological and non-technological business innovations (products, processes, organization, marketing). Like technological innovations, they are integrated into innovation cultures or social-cultural formations of innovation, each with their own specific character, and influence. While they are a "component of social change" they are not identical to it.

As cited by Chaminade et al. (2009), Lundvall (2007) argues that almost from the beginning, innovation systems research has taken two different perspectives, a narrow one, equalling innovation to science and technology, and a broader one, encompassing learning, innovation and competence-building at different levels of aggregation. They argue that the socio-economic context shapes the capability of organisations, regions or countries to develop diffuse and use innovations. They

see innovation as being embedded in specific social, political, and economic relationships, being largely influenced by the particular institutional context in which these relationships take place. The peculiarities of specific settings are therefore important to understand, as it is the context of each setting that will shape its S&T capabilities.

According to the Actor Brief on Public Research Organisations (OECD 2011) PROs typically get a significant part of their financial resources allocated through direct transfers from government (national and state-regional). These resources may come directly from particular departments or ministries with competencies in particular domains or indirectly, through a diversity of intermediary organisations such as Research Councils or Research Funding Agencies. Chandran (2010) makes a case that although government undertakes various initiatives to support and accelerate the rate of S&T, namely, by setting up institutions and programs (including grants), by and large, there still exist gaps that need urgent attention. Research institutions receive minimal grants from government which they have to use for S&T that contributes to national development. Early stage development funds can come from sources such as industry and companies that wish to explore new innovations, universities and other research institutions or government grants.

The Entrepreneurial Higher Education Institution report (2002) argues that knowledge transfer appears to work best when it is seen not so much as a relay race, but as a team effort. Then knowledge transfer is not a process in which, during the first few rounds of the race, the knowledge baton is kept inside the university and passed on to the outside world only during the last rounds. Rather, it is a game during which the ball moves continually between the players and in which all players have to collaborate and share resources to win. Based on the above, it is important for science councils to effectively collaborate in order to optimise opportunities for producing S&T and open knowledge flow channels.

David and Metcalfe (2007) argue that different objectives and modes of functioning, funding and organisation, may encourage or inhibit the coordination process, resulting in a less than efficient process that is envisaged by Alfred

Marshall in his Industry and Trade (1919). It is necessary to foster a growing commonality of interest and consequent collaboration between science and industry at the borderland between science and technology, which can perhaps be aided by public support. Next is an overview of the innovation landscape in South Africa.

2.3.1 South African Innovation Landscape

South Africa's science and innovation profile is mixed. While the country has a relatively strong national system of innovation, the lack of human capital is a major drawback. The country suffers from poor-quality schooling, worryingly low levels of entrepreneurship, a chronic shortage of high skills and underinvestment in S&T (NACI 2009; Marcelle 2010). As cited by the National Planning Commission, the OECD's *Review of South Africa's Innovation Policy* (2007), for example, reveals investments in S&T to be consistent with South Africa's status as a middle-income industrialising country, although the number of researchers (2.7 per 1 000 people) was far lower than that of peer countries (the OECD average was 8.0 per 1 000 people) and funding levels were also modest. South Africa's developmental status presents additional challenges as technological development and innovation may lead to greater social and economic inequalities.

Evidently, there is now a growing interest in the subject of innovation for social purpose. Institutions such as governments, OECD, NESTA, UNESCO, and others regard it as a distinct area of focus for policy. There has also been response to development challenges within Asia and Africa, as well as a proliferation of information on the subject (Netshiluvhi 2012).

Van Zyl, Amadi-Echendu, and Bothma (2007), South African-based researchers, make a claim that competition in the triple helix arena of government, industry and universities has meant that all three parties are required to sharpen their entrepreneurial skills to effectuate transformation of the South African science and technology landscape. It is argued that academics need to find ways to increase the relevance of their research to industry by reconsidering topic selection, as well

as by making improvements in the purpose, content and readability of the reports and articles they write. One key strategy is to improve the responsiveness in the higher education sector. Greater responsiveness implies that universities should take the problems and challenges presented by the societal context in which they operate seriously (HSRC 2003:1).

What is unique to South Africa is the specific situation in terms of the character of the built environment (such as cities and towns) on account of, for instance, the apartheid legacy, specific conditions in terms of climate, geographical location and geology, and the African heritage. In this regard, the infrastructure and the built environment are very different from consumer products such as cell phones, computers and cars that are readily transferable and/or purchasable from abroad. This implies that there is a need to foster unique South African technological solutions to solve problems and address the needs of the South African society.

There is compelling evidence that the creation of science councils, starting in South Africa with the Council for Scientific and Industrial Research (CSIR) in 1946, had a catalytic role in establishing the strong and diverse science, engineering and technology (SET) base that exists in the country today (CSIR Fellows 2007). The fact that there are now many large universities with strong research capacity and traditions, a private sector with substantive and well-resourced S&T capabilities, and hundreds of agile, low-overhead technical entrepreneurs, the role for science councils in South Africa might be questioned. In order to provide context, an overview of the CSIR as a science council in South Africa is provided next.

2.3.2 The Council for Scientific and Industrial Research as a Science Council in South Africa

Mandated by the Department of Science and Technology, in their evaluation of the CSIR as a science council; the CSIR Fellows (Scholes, Anderson, Kenyon, Napier, Ngoepe, and Weaver 2007 and 2008) found the following:

- There are many different ways of organizing such entities, which may be more

or less successful in different circumstances.

- Virtually all scientifically advanced countries have some portion of their science, engineering and technology (SET) capacity in partly government-funded dedicated research institutions despite having followed different development paths to get to that point.
- Large, multidisciplinary, significantly publicly funded R&D organizations are found in all successful innovation systems, regardless of their phase of development or sophistication.
- Academic institutions place their highest priority on curiosity and truth, while government agencies simply want implementable solutions that work.
- Instead of focusing on the areas of comparative advantage, science councils often try to be universities on the one hand, or private-sector consultancies on the other. At best this leads to sub-optimal S&T outcomes; damaging both the science councils and the entire innovation system.
- Companies are strongly focused on return to shareholders, which emphasizes delivery, to specification, on time and within budget. Interface organizations, such as science councils, have to be able to connect to all these cultures in the innovation chain.
- The time-constant of change is necessarily long because the building of high-level skills and effective large-scale organizations is slow, while the possibility of rapid collapse and loss of skills is real.
- It cannot be clear beforehand exactly what skills will be needed, and in what numbers. Skilled people also cannot be quickly generated on demand, posing a challenge to PROs.
- “Short-termism” is a major weakness of science councils. Science councils often perceive their income to be under threat, and sure only of their budget allocation for a single financial year, they do not commit to long-term, large projects where their advantage lies which they view as mostly self-inflicted constraint.

Based on the above findings, the CSIR Fellows (Scholes et al. 2008) made the following recommendations:

- Science council and their stakeholders, clients and governing bodies; need to balance the needs for accountability with the requirement for efficiency and a light management touch in order to nurture a productive research environment.
- There needs to be a relatively large and diverse pool of technical specialists, with skills kept honed by working in a challenging environment, to be deployed when needed. This is a function fulfilled by science councils together with higher learning institutions.
- When considering novel ideas for their innovation potential, sustainability of the organisation, its society and environment should always serve as a final consideration.
- To justify their privileged position as recipients of public funding not tied to specific projects, science councils and similar bodies need to ensure that they focus on fulfilling the role that they are best suited for: longer term, innovative and integrative research. Their project selection, evaluation systems, as well decisions on who to involve at what stage of the project must reflect this objective.
- The effectiveness of PROs require a particular culture of their own, characterized by pragmatism, project-orientation and trans-disciplinarity.
- Although firms and industries are important actors in innovation, other groups such as the users, societal groups, public authorities, research institutes are also relevant. While these groups have their own characteristics, they are also interdependent.
- Organizations that are insulated from the rigours of the marketplace can become complacent and unresponsive to stakeholder needs.

David and Metcalfe (2007) argue that research is the most critical component of any effective programmes serving ordinary people. The other stages include planning, implementation, monitoring and evaluation.

Scholes et al. (2008) make a case that for interfacial organizations such as science councils, too much public funding can be as detrimental as too little; that the optimum point is probably quite broad, situation and mission-dependent.

Internationally, examples of apparently sustainable science councils exist with between 25% and 80% baseline public funding. They cite that according to Walwyn and Scholes (2006) for South African circumstances, it seems that the level of 70% external funding reached by the CSIR in the 1990s was too high, but the 20% external funding up to the early 1960s was sustainable only in a start-up phase. They argue that a level closer to 50% would allow the CSIR to balance its public-and private-goods mandates more successfully.

They further make a case that on the other hand, as organizations mature and grow in size, they accumulate rules and structures. The dead hand of bureaucracy becomes increasingly dominant, and one of its manifestations is the inexorable upward creep of 'overhead' costs. Science councils are bound to satisfy both the onerous requirements of the Public Finance Management Act and the accounting demands of diverse external funders and clients.

The CSIR Fellows report (CSIR 2008), reflecting a self-critical the view of professional scientists working at the Council, notes risk aversion as a challenge facing science councils. Conscious of the need to generate short-term income, science councils tend to drift out of their core domain, which should be high-risk, pre-commercial research, into low-risk work that generates little new knowledge but a steady income. PROs become consultancies or technical service organizations, both of which have a necessary and valuable place in the S&T landscape, but in general should not qualify for the public funding which comes to science councils. The report acknowledges that there are circumstances where the skills held in the science councils may justifiably be applied to difficult, novel, specialized or nationally important consultancy or service tasks. Its authors go on to make the case that that when these come to dominate the activities, ethos and reward systems of the councils, then something has gone wrong. However, it is important to note here, that the CSIR fellows are predominantly white South Africans, whose social background and reality is likely distant from that of the majority of other South Africans, whose challenges, the CSIR is mandated to address. Thus, in spite of the critical disposition of the report, the balance of its judgments cannot be said to reflect that of the majority of the country. The

fieldwork that has been carried out in impoverished communities in this report will therefore contribute to giving a more holistic perspective of the impact of the CSIR's work on living communities.

Hobday (2005) makes a case for the importance of collaborations of relevant stakeholders, consideration of the context, addressing the needs and demands of the users, in coordinating the society as well as science in optimizing the systematic perspective on innovation. With a growing transformation of the principles and drivers of innovation from technology and science to processes of "co-creating" and "user-driven innovation" (Ibid p. 9). Public demand is considerable and remains important to economic activities; and could be used in a strategic way to stimulate corporate innovation for social purpose. This cannot be achieved with an innovation perspective that is focused solely on technology and the economy.

For innovation to be effective in changing the lives of people, it would have to be relevant to the needs of the target groups in society. Von Hippel (2005) notes that product development and modification by both user firms and users as individual consumers is frequent, pervasive, and important. It then becomes important to consider issues of social relevance of innovation which will be dealt with in the next section.

2.4 RELATIONSHIP WITH USERS

Figueiredo (2006), writing from the Global South, has also emphasized the importance of designing organisational and institutional arrangements in line with the need for technological change in the process of technological capacity building. Social needs should therefore influence the direction in which technology is developed. This is critical to allow use, benefit and sustainability of the technology unlike when it is based on S&T and is being pushed to society. Geels (2004) makes a case that notwithstanding their varied characteristics, the dynamics and relationships of the different stakeholders in PROs can affect how they respond to technology and innovation in their environments.

It is important to realise that the type of project as well as the context should be taken into consideration when comparing projects for making the investment decision. According to BEPA (2011) when the social relevance of the measure is self-evident in the object, social aspects are widely considered and quite developed throughout the assessment document. In other cases, where social elements are not at the core the effectiveness is less developed. Using the Frascati Manual as a guideline, most science councils apply considerable effort towards measuring the levels of impact of their work and not much consideration about whether it is socially relevant. According to the World Bank (1994: p. 6) as cited in Nelson and Wright (1995: p. 5) participation involves stakeholders who "influence and share control over development initiatives, decisions and resources which affect them".

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As cited by Chaminade et al. (2009), Lundvall (2007) argues that the socio-economic context shapes the capability of organisations, regions or countries to develop, diffuse and use innovations. They see innovation as being embedded in specific social, political, and economic relationships, as well as being largely influenced by the particular institutional context in which these relationships take place. The peculiarities of specific settings are therefore important in understanding as it is the context of each setting that will shape its S&T

capabilities.

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According to Cornwall (2002) participatory development (PD) seeks to engage local populations in development projects. Cornwall reports that PD has taken a variety of forms since it emerged in the 1970s, when it was introduced as an important part of the "basic needs approach" to development. Most manifestations of PD seek “to give the poor a part in initiatives designed for their benefit” in the hopes that development projects will be more sustainable and successful if local populations are engaged in the development process. Mohan (2008) suggests that PD has become an increasingly accepted method of development practice and is employed by a variety of organizations making use of the basic needs approach. PD seeks to engage local populations in development projects an important aspect of project management.

Watkins and Tacchi (2008) make a case that PD employed in particular initiatives often involves the process of content creation. They suggest that local content creation and distribution contributes to the formation of local information networks. This is a bottom-up approach that involves extensive discussions, conversations, and decision-making with the target community. With this approach, community members create content according to their capacities and interests. This process

facilitates engagement with the goal of strengthening individual and social development. They argue that participatory content creation is an important tool for poverty reduction strategies and creating a digitally inclusive knowledge society.

As cited by Mohan (2001), (Village AiD1996: 7) suggests that undertaking particular projects that are not a high priority for the village, but were undertaken at the suggestion of organisations such as NGOs are a danger. They argue that ideally village communities should set the agenda and outside agencies become responsive to those agendas. Mohan highlights mapping and ranking of preferences by communities as part of the PRA toolkit. This scholar argues that PD seeks out the diversity which allows the differences between people and between communities to be realised rather than treating everybody as uniform objects of development. Mohan further claims that participation can be used to 'smooth' the implementation of a pre-determined project. He supports the claim that agencies carrying out community development projects need to be flexible “not in its basic objectives, but in its systems and procedures” (ibid: 75) so the goals are circumscribed from the outset.

O’Malley (2004) suggests that people should be involved in development programmes by being made part of the decision-making on where infrastructure is located, by being employed in its construction and by being empowered to manage and administer these large-scale programmes. Based on the above, user involvement in projects from conceptualisation, during implementation, as well as in monitoring and evaluation is a very important aspect for ensuring the social relevance of S&T.

2.5 PURPOSE OF SCIENCE AND TECHNOLOGY

OECD (2011) confirms that the increasing demand for research that is both relevant and excellent have led PROs to aim for greater management flexibility and to search for diversification of funding sources in order to increase their autonomy. This report suggests that trends regarding PROs are quite stable. In the near future, it is unlikely that there will be “radical” innovations in the core motivations and interests of PROs, but rather incremental adaptive processes

and reforms at different speeds depending on the type of organisation. The authors further suggest that the question of which institutional arrangements allow PROs to perform roles that combine excellence and relevance is not an easy one. The main institutional dimension that affects the capacity of PROs to select and perform their roles include: the degree of autonomy with respect to the political system as regards its budget, and the ability to make decisions on employment and structure.

Kadekoki (2009) emphasized that time has come to seek solutions to worldly problems on a 'unified science' basis. Social science therefore cannot stand in isolation as providing solutions to all problems, but it might be useful to recount the social issues to be kept in mind while we seek technological and scientific solutions. He highlighted that way back in the 1930s Albert Einstein spoke on different occasions about making science and technological development based on more and more societal decisions. This shows that this is not a new school of thought or a unique situation. Science therefore needs to be relevant to societal problems. As cited by Read (2000) it is very important to distinguish between inventions and innovation when looking at S&T. Unlike an invention, innovation must be *useful* (Gronhaug & Kaufman 1988; Padmore, Schuetze & Gibson 1997; Cooper 1998). This makes it important to consider the needs of the users or for the users to make an input in S&T production to ensure its usefulness.

The OECD (2011) shows that globally, in the last decades, despite the predominant role of block grants and direct transfers, governments have put more emphasis on competitive and program funding as a way to steer research and implement priorities. Although it should be noted that block grants still represent the highest share of public funding for PROs. As cited in the OECD (2011), Nedeva and Boden (2006) argue that this trend has raised some concerns on the part of PROs in terms of their long term capabilities to address frontier and fundamental research or to provide independent advice to governments. These changes in the funding regime have not affected all PROs equally. Depending on the specific sector or field, but also the level of control these organisations have over their own budgets, some types of PROs are better equipped to compete,

collaborate and contract with other actors.

Howaldt and Schwarz (2010) suggest that this dual determination in scientific conceptions of social innovation as being equally analytical and normative prompts the need to investigate the value aspect of innovation for social purpose. They argue that attempting to provide a distinct definition of social innovation normatively is problematic because after all, even technical innovations can contribute to solving social needs and meeting social challenges. They make a claim that we are currently in the midst of a phase in which innovation is no longer shaped by industrial and key technologies but is instead informed by a "science-based society" wherein markets are determined by the "demand for products, systems and services focused on knowledge and learning" (Ibid., p. 151).

BEPA (2011) advocates for conceptualising innovation within a sustainable development perspective, in which the creation of well-being is valued as a separate dimension from economic output. In this sense, the boundary between the social and the economic domains blur, and the 'social' becomes an opportunity, rather than a constraint to generate value. In other words, instead of complementing economic innovation with a social dimension, this view aims at 'reforming' its very meaning. Here, innovation is seen as a process that should tackle 'societal challenges' through new forms of relations between social actors. According to this view, social innovations are innovations that respond to those societal challenges in which the boundary between the social and economic is blurred , and is directed towards society as a whole.

Innovation for social purpose, borrowing from Crozier and Friedberg (1993) can be "interpreted as a process of collective creation in which the members of a certain collective unit learn, invent and lay out new rules for the social game of collaboration and of conflict or in a word, a new social practice, and in this process they acquire the necessary cognitive, rational and organizational skills" (Crozier and Friedberg 1993, p. 19). They argue that social innovations, understood as innovations of social purpose, are an elementary part of

sociology, and therefore in contrast to technical innovations can be not only analysed, but also engendered and (co-)shaped; they are oriented toward social purpose and require reflection on the social relationship structure.

According to the BEPA (2011) innovations for social purpose are innovations that are social in both their ends and their means. Specifically, these are new and/ or improved ideas (products, services and models) that simultaneously meet social needs (more effectively than alternatives) and create new social relationships or collaborations. They are innovations that are not only good for society but also enhance society's capacity to act. This happens through *interactions* between individuals undertaken to reach certain outcomes, is participative, and involves a number of actors and stakeholders who have a vested interest in solving a social problem, it also empowers the beneficiaries.

2.6 PERSPECTIVE ON DEVELOPMENT

According to (Howaldt and Schwarz 2010) there are similarities as well as differences between social innovations concerning societal issues, and innovations based on technologies aiming at business purposes. Social innovations are distinct from technological innovations in as much as the intended purpose and objectives differ, notwithstanding outcomes such as improving economic performance may overlap.

Aubert (2004) argues that innovation flourishes in well-defined regions where there is a concentration of talent, energy, and vision. It is also crucial that support be delivered as close as possible to enterprises, as they are dispersed on the territory. For this it is important to mobilize local communities to create a strong ownership. This calls for enough autonomy for project selection and funding, and matching funds by which local authorities are stimulated to spend resources on infrastructure and other innovation programs with a social purpose. These approaches should be simple methods of voicing social needs with a certain transparency in delivery thereof. Innovation should thus not only be technologies that can make high level impact but those that are effective in directly making a

difference in people's lives.

Rahnema (1992) suggests that PD involves the following core elements of change:

- *cognitive* in order to generate a "different mode of understanding the realities to be addressed" (ibid.:121)
- *political* for "empowering the voiceless" (ibid.: 121)
- *instrumental* in order to "propose new alternatives" (ibid.: 121)

2.6.1 Participatory Development in Water Development

Participatory development is an approach that is recommended for development projects (Cornwall 2002; Mohan 2008; Taylor and Francis 2000). According to Mohan (2007) suggests that PD emphasize a difference between participation as "an end in itself", and participatory development as a "process of empowerment" for marginalized populations. A United Kingdom based scholar, Osmani (2007) makes a case that this has also been described as the contrast between valuing participation for intrinsic rather than purely instrumental reasons. The celebrated Indian economist, Sen (2002), suggests that in the former manifestation, participants may be asked to give opinions without any assurance that these opinions will have an effect or that they may be informed of decisions after they have been made. In the latter form, proponents assert that PD tries to "foster and enhance people's capability to have a role in their society's development".

According to Chambers (1997: 103) the essence of participatory rural appraisal (PRA) is change and reversals of role, behaviour, relationship and learning. Chambers explains that:

> "Outsiders do not dominate and lecture; they facilitate, sit down, listen and learn. Outsiders do not transfer technology; they share methods which local people can use for their own appraisal, analysis, planning, action, monitoring and evaluation. Outsiders do not impose their reality; they encourage and enable local people to express their own".

UNDP (2004) evaluated the water development governance alongside the relevant challenges and opportunities. The following were the findings and recommendations of their report:

The report argues that aspects of the crisis suggests that in order to address development issues in a holistic way, PROs need to ensure that actions taken in one area, such as sanitation, do not worsen conditions in another, such as the environment; this requires capacity for cross-sectoral planning and policy making, an ability that is lacking in many developing countries and many donor agencies, as well.

In this booklet, the UNDP reports weak capacity as a major impediment to the provision of water and sanitation services and the sound management of water resources. In the water sector, reforms and the decentralization of service provision have created huge capacity and resulted in agreed demands. In addition to the long-term requirements for graduates and skilled personnel, much greater attention must be paid to the immediate capacity needs of government and civil society to support policy, legal and institutional reforms. This is a serious issue at all levels. Decentralized, community-based institutions are effective vehicles for helping poor communities' access water and sanitation, but these emerging groups need tremendous support to advocate effectively for their needs and manage resources fairly and sustainably.

UNDP (2004) makes a case for organising development interventions so that information exchange and cooperation among stakeholders takes place. This involves negotiation, improved capacity building and collective planning and decision making taking place in an atmosphere of confidence and trust. It advocates that projects and programmes are designed so that they are facilitated by the project team, communities will actively participate in the water sector, a critical leverage point for issues of poverty alleviation in cities, and in the development of beneficial relationships with private service providers.

A case is made that such relationships would amongst other things enable

community representatives to understand the key issues involved in water supply, empower them to know how to handle water leakages and other problems in order to reduce losses, create public awareness of the rationale for private sector participation in public service delivery, as well as help avoid the confusion and resistance often seen in the reform of public service in developing countries. The involvement of community representatives from project conception therefore becomes crucial.

According to Mohan (2001) 'normal' development is characterised by biases which are disempowering (Peet and Watts, 1996: 20-25). These biases include Eurocentrism, positivism, and top-downism (Escobar, 1995; Chambers, 1997). Advocating participatory development (PD), Chambers (1983) argues that “putting the last first) is the only way to achieve rural development. UNDP (2004) argues that in order to alleviate the detrimental effects of poor water management and a lack of adequate financial resources, partnerships at all levels with multiple stakeholders must be fostered. The programme advocates for the empowerment of the poor to participate in decisions that affect their lives. The programme encourages politicians, decision makers and other stakeholders to facilitate the required changes in water governance with solutions that respond to the priority needs of water users.

Based on the above, the participation of users and stakeholders in co-shaping science, innovation and technology is at the core of innovation for social purpose. The next section looks at making science and technology socially relevant.

2.7 OVERALL RELEVANCE

The Indian scholars, Dasgupta and Gupta (2009) define innovation as “typically understood as the successful introduction of something new and useful” . They suggest that these may include new methods, practices, techniques, products or services. These scholars make a case that radical innovation results in extreme change to existing processes, practices, products etc., while incremental innovation leads to gradual, or step-by- step improvement.

The UN System Task Team (2011) makes a case that governments will find it difficult to raise living standards in a sustained manner, feed their growing populations, keep their children healthy, and protect their environment, if they cannot find better, cheaper and smarter ways of producing goods and bringing them to the market. They argue that the future holds other challenges where new technologies will be key, particularly where climate change is involved. They further suggest that in both traditional and frontier markets, competition between innovators will be critical to ensure the development of socially useful products and processes at affordable prices. They argue that however, for many developing countries, persistent obstacles will need to be addressed through a global partnership for development.

Brazilian scholars, Cassiolato et al. (2008) make the case that one should avoid interpreting socially oriented innovation as the mere act of developing or making available “appropriate” technologies. They argue that palliative interventions designed and focused on extreme poverty situations that lack a broader systemic approach usually fails to be sustainable in the medium and long term. They further state that the approach cannot be restricted to focalized solutions for alleviating poverty or other specific deficits if the ultimate goal is social inclusion. According to these scholars, improvements due to innovation should also generate a broader dynamic process of societal change, including the generation of local learning processes and capabilities for problem resolution.

According to Von Hippel (1986) end-users, rather than manufacturers, are responsible for a large amount of innovation. In order to introduce the idea that more users and consumers are the innovators of new products instead of suppliers, he makes developed the term “lead user”. Von Hippel notes that lead users face needs that will be general in a marketplace – but face them months or years before the bulk of that marketplace encounters them. This means that users could first feel the need for a product or service and create it for themselves. Often these ideas are then fed back to manufacturing companies through these users in hopes that the product will then be produced for them. He further suggests that lead users are positioned to benefit significantly by obtaining a solution to their

needs. This scholar argues that commercial attractiveness of innovations developed by users increased along with the strength of those users' lead user characteristics. This assertion is claimed to be based on the lead users' high levels of use experience.

The OECD LEED Forum on Social Innovation (OECD 2008) in defining social innovation indicates that it will "deal with improving the welfare of individuals and community through employment, consumption or participation, its expressed purpose being to provide solutions for individual and community problems". A case is made that existing business innovation also aims to improve social welfare or human well-being; however, social innovation is believed to be separate from the commercial interest of making a profit but focused more on creating or offering better solutions for people.

BEPA (2010) claim that innovations that involve beneficiaries in design and diffusion processes are better placed to ensure that they address their needs and produce positive and potentially significant impacts on their empowerment. Chambers (1983) makes a case that PD reverses the biases which have marginalised and alienated the poor stressing the necessity of local knowledge. The approach is reported to reverse normative social models that treat the recipients of development as passive or, more often as conservative and obstructive; while it centres on trying to see the world from the point of view of those directly affected by the developmental intervention. The usefulness and relevance of science and technology is therefore important to ensure overall relevance.

2.8 SUMMARY OF THE LITERATURE REVIEW

The literature reviewed shows that in both the Global North and South, the mandate of science and technology ministries and agencies is to harness S&T to support the social and economic development of nations. Although independent assessments of the CSIR in South Africa are limited in the peer-reviewed

literature, research emanating from comparable settings (middle income countries with high levels of inequality such as Brazil and India), convincingly suggests that public research organisations should and can play an important role in carrying out this mandate. In order for PROs to be effective in doing this, they need to be well managed, adequately funded and equipped with relevant infrastructure , and have a suite of collaborations as well as capabilities. Literature makes a case for the openness, interdisciplinariness, as well as responsiveness of S&T. More importantly PROs need to follow the best suited approaches in producing science and technology.

The user-centered innovation process is in sharp contrast to the traditional model, in which products and services are developed by manufacturers. According to literature there is a growing body of empirical work showing that users are the first to develop many and perhaps most new industrial and consumer products. It is highlighted that tapping into their experience and knowledge; users can be the driving force of innovation. This calls for the involvement of users in shaping and developing science and technology.

The participatory development approach has been advocated to be the best approach for purposes of developmental projects. PD has become an increasingly accepted method of development practice and is employed by a variety of organizations. Its strengths include taking into account the basic needs of communities and seeking to engage local populations in development projects as an important aspect of project management. Based on the literature reviewed, if PROs adopt participatory development approaches, they are likely to increase the usefulness and relevance of their work.

The research question that needs to be answered by this research is:

To what extent is the science and technology (S&T) produced by science councils relevant to social needs of community members and stakeholders?

CHAPTER 3: RESEARCH STRATEGY AND METHODOLOGY

This chapter describes the research methodology, design, respondents, research instrument and various aspects of data collection as well as analysis relating to the research. These are described alongside the biographical profile of the respondents in this study.

3.1 RESEARCH METHODOLOGY

The researcher used the case study research method to explore the social relevance of S&T produced by science councils in South Africa. According to Yin (2009), the case study approach is used in many situations, to contribute to our knowledge of individual, group, organisational, social, political, and related phenomena. Yin argues that the more the questions seek to explain some present circumstance (e.g. “how” or “why” some social phenomenon works) the more that the case study method will be relevant. According to him, the more relevant the method the more the study requires an extensive and “in-depth” description of some social phenomenon. The researcher chose the case study method due to the fact that the study addressed the question of how the S&T produced by science councils is relevant to improving the quality of life of people in South Africa.

3.2 RESEARCH APPROACH AND DESIGN

A qualitative research approach was followed. Qualitative research is “used to answer questions about the complex nature of phenomena, often with the purpose of describing and understanding the phenomena from the participants’ point of view” (Leedy and Ormrod 2005:94). Cooper and Schnidler (2011) define qualitative research as “an array of interpretive techniques which seek to describe, decode, translate, and otherwise come to terms with the meaning, not frequency of certain more or less naturally occurring phenomena in the social world”. A qualitative research design was adopted due to the explorative nature of the study. The research was aimed at obtaining an in-depth understanding of the social

relevance of the S&T produced by science councils in South Africa.

Cooper and Schindler (2011) explain that qualitative research can help the researcher to achieve an in-depth understanding of the different meanings that people place on their perspectives and that this approach required research techniques that delve deeply into people's hidden interpretations, understandings and motivations. Qualitative research thus became relevant as a means of research inquiry to define what is important, when little information exists on a topic, when variables are unknown and when a relevant theory base is inadequate.

A qualitative approach allows the researcher to obtain data from a variety of sources (Cooper and Schindler 2011), including:

- People (individual or groups) in their natural settings;
- Organisations or institutions;
- Texts (published, including virtual ones);
- Settings and environments (visual, sensory and virtual material);
- Objects, artefacts, media products
- Events and happenings

For the purpose of this study data were collected from users of innovation (individuals and focus groups), stakeholders in the communities, the CSIR as an organisation, as well as from documents within the CSIR.

3.3 RESEARCH STRATEGY

This study used a combination of primary data collection and document analysis. Two communities where water management projects implemented by the CSIR Built Environment operating unit in the Amathole Municipal District as well as the Greater Sekhukhune Municipal District are the case sites. The researcher elicited data from specialists which included R&D Managers and researchers, as well as reviewing relevant documents within the CSIR.

A number of different methods of data collection at community level were

employed; these included participant observations and focus group discussions. In working with local communities, particularly in rural settings, it was also important to negotiate access through municipal, traditional and culturally relevant authority systems and this has been taken into account in the design. The researcher also conducted focus group discussions with community members and stakeholders.

3.3.1 Respondents

The research respondents for this study were producers of S&T. These included R&D Managers, as well as researchers that had been involved in producing S&T in the CSIR as one of the science councils in South Africa. The case of the CSIR Built Environment operating unit was selected for the study, with specific focus on water provision projects.

The researcher also elicited data from users of technology through focus group discussions. These included community members as well as other stakeholders in communities where water provision S&T produced by the CSIR as a science council had been implemented (Table 1).

Table 1: Community level users of technology and stakeholders participants

Name	Position/ Role	Project	Project Type	Location	Province
Focus Group 1	Users	ASWSD I	Water provision	Dresden	LP
Focus Group 2	Users	ASWSD I	Water provision	Dresden	LP
Focus Group 3	Task Team	ASWSD I	Water provision	Dresden	LP
Focus Group 4	Users	ASWSD II	Water provision	Amathole	EC
Focus Group 5	Users	ASWSD II	Water provision	Amathole	EC
Focus Group 6	Task Team	ASWSD II	Water provision	Amathole	EC

*EC - Eastern Cape; LP – Limpopo
*ASWSD - Accelerating Sustainable Water Services Delivery

A larger sample is considered beneficial in most cases (Leedy and Ormrod 2005). Participation of 30 respondents was sought in this research. This was considered appropriate for this study as qualitative aspects are included in the mixed methods research design. Additionally, time and cost constraints were considered prohibitive to including more participants in the study. As Rea and Parker (1992:16) indicate “the researcher must weigh the degree of desired accuracy against the increased time and cost that a larger sample size entails”. As a result, the findings are reported tentatively and should not be considered as conclusive.

The research instruments for this study will now be described.

3.4 THE RESEARCH INSTRUMENTS

The research instruments for this study took the form of an interview protocol as well as a focus group discussion document. Both instruments had structured and unstructured components as some questions were answered earlier in the discussions. The research instruments are novel, i.e., they have been designed specifically for the purposes of this research and no part of both has formed a part of previous research protocols.

The instruments were designed with various guidelines in mind as recommended by Boyce (2006) the interview guide lists the questions or issues to be explored during the interview. An informed consent form was also developed for the participants to complete. There were no more than 15 main questions to guide the interview, and probes were included where helpful. Different discussion documents were developed for the users and the producers of S&T respectively as they needed to answer different questions.

As cited by Turner (2010), McNamara (2009) suggests several recommendations for creating effective research questions for interviews which includes the following elements:

(a) wording should be open-ended (respondents should be able to choose their own terms when answering questions);

(b) questions should be as neutral as possible (avoid wording that might

influence answers, e.g., evocative, judgmental wording);
(c) questions should be asked one at a time; (d) questions should be worded clearly (this includes knowing any terms particular to the program or the respondents' culture); and
(e) be careful when asking "why" questions.

The researcher also followed the above mentioned recommendations when developing questions for the interviews and the focus group discussions.

3.4.1 Focus Group Discussion Protocol

Creswell (2007) believes that the researcher must construct questions in such a manner as to keep participants on focus with their responses to the questions. In addition, he recommends that the researcher must be prepared with follow-up questions or prompts in order to ensure that they obtain optimal responses from participants. The interview protocol is composed of 15 main questions, some with additional probing questions. The cover page of the focus group discussion protocol also included the agenda. The printable version of the focus group discussion protocol is presented in APPENDIX A.

The cover pages of both protocols explain the background, purpose and potential beneficial impact of the research. The cover page of the focus group discussion protocol also included the agenda.

3.4.2 Science and Technology Producers Interview Protocol

The interview protocol was developed in English which is the language in which all interviews were conducted. The literature review was used as a means to determine and structure the protocols and their variables. The research instrument was adapted to ensure that it was easily understandable and simple to respond to. The focus group discussions lasted for about 45 minutes to an hour. The protocol was designed to be relevant to water provision projects in underserviced

communities. The printable version of the interview protocol is presented in APPENDIX B.

As mentioned previously, Creswell (2007) is of the opinion that the researcher's questions need to be constructed in a way that keeps participants focused when responding to the questions. In addition, he recommends that the researcher must be prepared with follow-up questions or prompts in order to ensure that they obtain optimal responses from participants. To this end, the interview protocol was adapted to ensure that it was easily understandable and simple to respond to. The interviews lasted for about 45 minutes to an hour. The protocols were composed of 5 sections which included the following:

a) Biographical Information
b) Project Background
c) Power and Decision Making
d) Project Funding
e) User Involvement; and
f) Relevance

3.4.3 Consent to Participate

A separate consent form that included a respondent confidentiality clause was signed by all participants. The consent form explained the background, purpose and potential beneficial impact of the research. The printable version of the consent form is presented in APPENDIX C.

3.5 LIMITATIONS OF THE STUDY

The subject of social relevance is insufficiently researched hence the study borrows a lot from the concepts of "innovation for social purpose" as well as "participatory development". This is evidenced by the limited number of references to scholars from the Global South in terms of innovation management publications. The limitation resulted in a lack of well-established assessment criteria for the social relevance of innovation.

The researcher had not established a working relationship with the respondents who were requested to participate in this study in the selected communities. Respondents might not have been keen to divulge certain information. This might have influenced the number of respondents who agreed to participate in the research.

The researcher did not have extensive knowledge of the decision-making processes by science councils in determining S&T projects. However, limited knowledge of the industry could in some instances inhibit or limit bias on the researcher's side during data interpretation.

Due to the amount of research done in the communities, the respondents seemed disgruntled which could have influenced their willingness to participate in the study. There seemed to be an overwhelming number of researchers going to these communities although the benefits of the various research conducted was apparently not often realised.

The number of respondents was small and intentionally non-random i.e. purposeful. The respondents were identified according to the communities where water provision projects based on S&T produced by the CSIR Built environment operating unit has been established. In some instances, limited participation in focus groups limited chances of obtaining a diverse range of responses in order to make comparative analysis.

Due to location, time and financial considerations the researcher was not able to conduct in-depth interviews with more community members who are users of S&T produced by science councils. The study only focused on the social relevance of S&T produced by science councils and not its impact as it would not be possible at this stage to establish financial measures that monitor and assess the situation before and after the S&T has been produced and implemented in the respective communities.

Due to issues of Intellectual Property and commercialisation, the researcher was not able to engage with some of the S&T projects due to their developmental stages. The case of the CSIR as a research institution was explored and it is relevant to note that the researcher is also an employee of the same organisation.

3.6 ETHICAL CONSIDERATIONS

This study stringently adhered to the ethical practices and high standards in conducting research of this nature as articulated by the institutional bodies that are responsible for its approval. The study subscribed to strict Code of Ethics of the CSIR. It was approved by the CSIR Ethics Committee before commencing. Additionally, the Code of Conduct of the Wits Business School (WBS) sets clear guidelines and standards for the use of research information and personal details of respondents.

The researcher obtained the approval of the respective Municipal Management in the two District Municipalities, as well as the Tribal Authority in the two villages. Participation in the study was voluntary and participants were informed about the nature of the study prior to being asked to participate. Refusal to participate in the study was accepted at any stage during the course of the research. Due to issues of intellectual property as well as commercialisation, the primary data were at all times treated as confidential information by the researcher. The primary data were then analysed and the reviewed information that does not contain any names of organisations or the respondents can then be accessible to the general public.

Data analysis was not manipulated or biased as that constitutes unethical conduct. The research findings were only discussed with the supervisor with the names of the community members and projects omitted and represented by specific codes.

3.7 SUMMARY OF THE RESEARCH STRATEGY AND METHODOLOGY

An exploratory research approach was adopted for the purposes of this study in order to explore findings in an inductive manner and to build a framework, which offered a better understanding of the social relevance of S&T produced by

science councils in South Africa. Cooper and Schindler (2010) state that explorative research helps a researcher develop key concepts of the study more clearly, establish priorities, develop operational definitions, and improve the final research design.

The researcher used a qualitative case study design. To collect the data from the 46 respondents the researcher administered two discussion guides, one for interviews and the other one for focus groups. The interview questions included both closed and open-ended questions. The respondents were selected both purposively and conveniently based on their availability and willingness to participate in the study.

The respondents in of this study included community members and stakeholders who are mentally sound, who are members of the selected communities, and were willing to participate in the study. It also included researchers at the CSIR who have worked on the projects or reviewed the projects, as well as R&D Managers at the CSIR. Permission was obtained from the CSIR, Wits Business School, District Municipal Managements as well as the Tribal Authorities in the selected communities. Written consent was obtained from the subjects themselves. Voluntary participation, self-determination as well as confidentiality were ensured during the administration of the interviews, focus group discussions, as well as report writing.

The researcher personally conducted the interviews and focus groups. Interviews were chosen as they were targeted, focusing directly on the case study topics. They were also insightful providing perceived casual inferences and explanations as cited by Yin (2009).

Focus groups allowed the researcher to minimize costs, get views of more people at the same time, as well as facilitate discussions and sharing of opinions by the respondents on the subject matter. Visiting the communities allowed the researcher to observe the conditions in the different communities in relation to the research subject matter. Interviews were chosen as they were targeted, focusing directly on the case study topics. They were also designed to be insightful and

to provide perceived casual inferences and explanations (Yin 2009).

This chapter describes the research methodology, including the research approach, strategy and design, as well as data collection instruments and strategies that were used to ensure the ethical standards of the study.

CHAPTER 4: PRESENTATION OF FINDINGS AND DATA

This chapter presents the study results in detail. The chapter is organised as follows: background discussion on the two case sites selected for the study as well as of the CSIR. This is then followed by demographic details of the respondents, and a detailed presentation of the findings and data. For ease of reporting, the results are presented in the sequential order used in the research instruments. Result presentation may take the form of numerical, graphical and narrative formats.

4.1. The CSIR as a Formal Science and Technology Organisation

The Council for Scientific and Industrial Research (CSIR) is one of several science councils in South Africa which are responsible for scientific and technology research, development and implementation. South Africa's CSIR was established in 1945 as a science council by an Act of Parliament. It is a parastatal that is required to contribute to S&T in South Africa by undertaking integrated, multidisciplinary research across diverse areas of science.

The detailed mandate of the CSIR is set out in the Scientific Research Council Act, (Act 46 of 1988, as amended by Act 71 of 1990), section 3 is as follows:

> The objects of the CSIR are, through directed and particularly multidisciplinary research and technological innovation, to foster, in the national interest and in the fields which in its opinion should receive preference, industrial and scientific development, either by itself or in co-operation with principals from private or public sectors, and thereby to contribute to the improvement of the quality of life of the people of the Republic, and to perform any other functions that may be assigned to the CSIR by or under this act.

The CSIR works closely, either as a partner or a client, with tertiary educational institutions, other science councils, research institutions and a range of private sector organisations locally and abroad. According to internal corporate

documents, the CSIR places a focus on quality science, skills and socio-economic improvement.

The council owns and/or manages a number of specialist facilities of national importance. These include centres for laser technology, satellite applications, nano-structured materials, high-performance computing, notational analysis of sports performance, coastal engineering and other modelling facilities, as well as testing facilities for wind resistance, mine hoist equipment, environmental samples and more. CSIR receives an annual grant from Parliament through the Department of Science and Technology (DST), which accounts for some 40% of its total income. This is invested in knowledge generation, scientific infrastructure and enhancing skills.

The CSIR's total operating income is more than R1 billion per annum. Income generated from contract research for public and private sector clients, locally and abroad, as well as from royalties, licenses and dividends from intellectual property (IP) management and commercial companies created by the CSIR is added to the income directly from government. CSIR earns in excess of R30 million in royalties per annum and also earns fees from consulting and analytical services that range from project management and fieldwork, and specialist testing.

The council has a dedicated unit for enterprise creation to facilitate the implementation of community-owned, technology-based businesses that generate innovative products and employment opportunities. CSIR has a staff complement of around 2, 300, of which close to two thirds are science, engineering and technology (SET) specialists; of these 50% are qualified at Master's level and higher. CSIR invests in human capital development through undergraduate and postgraduate bursaries, internships and a range of training interventions to foster young talent and further develop expertise.

4.2 Description of the Project

According to internal reports, the project implementing agencies were appointed in 2009 and the project has been executed in two rural locations, namely the Amathole District Municipality, Cwebe Village and the Greater Sekhukhune

Municipality in Dresden Village. The CSIR assumed responsibility for technical research and development, as well as the project management in the ADM. The HSRC was responsible for the community mobilisation and training in both district municipalities, as well as project management in the ORTDM. At inception, the project began with identification and selection of intervention sites/communities, the conceptualisation of the communal water station and associated community mobilisation activities. The commencement of the ASWSD 1 project was officially launched in February 2009 at Cwebe village in the ADM and at Mnxekazi village in the ORTDM by the then Deputy Minister of Science and Technology, Mr Derek Hanekom.

The design specifications for this project focus on the construction of communal water stations (CWS) at traditional water collection points near rivers and boreholes in these villages. The project was also aimed at ensuring sustainability through the establishment of participatory institutional arrangements for the operation and maintenance of both these communal water stations and existing boreholes. In terms of the formal scientific and technological content, there are three elements, viz;

- The installation of a communal water station to extract and treat water from a river.
- The development of a borehole management plan that aims to improve safety of borehole water and minimise breakdowns.
- The provision of a household-based water treatment technology for the purification of water in the home.

The communal water stations for the villages in the ADM were conceptualised to produce a volume of at least $3m^3$ of potable water per hour and to consist of at least a flocculation and settling tank, pressure filters, a chlorination tank and a storage tank. Potable water is pumped from the storage tank in the CWS to a reservoir, from where safe water is distributed to pipelines and then to taps in the respective villages through gravity. Interestingly, the design of the CWS envisaged using its energy system as a communal cellphone charging system. The energy

source for the water stations in Cwebe was diesel generators while electricity was used in Dresden. In the case of Dresden village, the District municipality provided JoJo water tanks for the storage of water in the village. For villagers who lived far from the communal water station, a household-based water treatment technology known as the *Amadrum* was provided to each household for water purification.

In the ADM, the project was rolled out in three villages; Cwebe, Mbelu and Ntilini. The main agricultural activities in these locations are vegetable gardening and dry land farming of maize with cattle manure used as an organic fertiliser. All these villages are located relatively close to rivers. Almost all the households are located on top of a ridge along an access road. The river in these villages is some distance away in a ravine. Households rely mainly on springs and these rivers as their water source. All springs are located down slope in relation to the dwelling places, at an average distance of 50 - 100m.

There are only a few sanitation facilities/toilets in these areas and as a result, most households practice open defecation. Human waste is often as close as 10m from water sources. Households and animals share water sources, with cattle and domestic animals using the same rivers and streams as humans and there are few if any fences or other forms of protection. The project aimed to allow the community to use traditional paths to fetch drinking water while greatly improving safety of the water, instilling greater attention to operation and maintenance of system components.

The project aimed at servicing an estimated 1 200 households; internal assessment reports suggest that 1 775 households (8 989 people) benefitted from the ASWSD 1 project by obtaining access to clean drinking water. At the time of issuing the report, the project had not been subject to any independent evaluation and the internal project reports have not been finalised by the funder.

4.3 The Project Case Sites

This section provides background on the two communities that were selected for the purpose of this study. These are in two of the nine provinces in South Africa.

The biographical profile for each of these two case sites is presented next.

4.3.1 Case Site 1: Cwebe Village

Amathole is one of the seven districts located on the eastern seaboard of South Africa in the Eastern Cape Province. Over 90% of its 1,664,259 people speak Xhosa (Census 2001). "Amathole" means calves, and is similar to the name of the mountain range and forest which forms the northern boundary of the district (du Plessis, 1973). The district municipality was established after the first local government elections under a democratic government in December 2000.

As shown in Figure 2, the district stretches from the Indian Ocean coastline in the south to the Amathole Mountains in the north, and from Mbolompo Point (just south of the Hole-in-the-Wall along the Transkei Wild Coast) in the east to the Great Fish River in the west.

Statistics South Africa (2007) indicated that this is a rural location and one that is ravaged by high levels of poverty. The majority of the poorest of the poor live in dwellings that are constructed with mud and low quality building materials which are vulnerable to being affected by severe weather conditions. The area suffers from a heavy backlog in provision of formal housing. Household grant dependence is higher in Amathole (66%) than the provincial average for the Eastern Cape (64%).

The people of ADM rely on many national departments such as Departments of Social Development and Rural Development and Land Reform for relief and assistance as well as on provincial and local authorities. Unemployment continues to be a challenge in the area. According to the South African Local Economic Development Network (SA LED Network) the following sectors provide employment in the formal sectors, with the number of jobs across each being: public services (75,000); manufacturing (27,000); trade (25,000); and agriculture (17,000). The South African LED Network (2010) defines itself as an organisation that aims to induce economic development and growth in a locality with the objective of creating jobs and improving the quality of life for everyone by

realizing a locality's full comparative advantage. It strives to improve the understanding of local economies by promoting discussion and exchange between the various kinds of LED practitioners to build a body of knowledge on effective strategies and measures.

There has been a rapid growth in informal settlements in Amathole which puts a great deal of pressure on health and environmental standards. Public agencies struggle to provide basic services such as housing, safe water and sanitation, education, reproductive health, and youth development. There are funding and organisational challenges and local as well as national government departments have a poor track record in terms of delivery of impactful development projects that help improve the quality of life of the residents in the district Municipality. The District Municipality is made up of a few former homelands. Here, limited or no development has taken place over a number of years. The public sector dominates the region's economy, there is a limited production base and there has been very limited private investment growth into the ADMs economy.

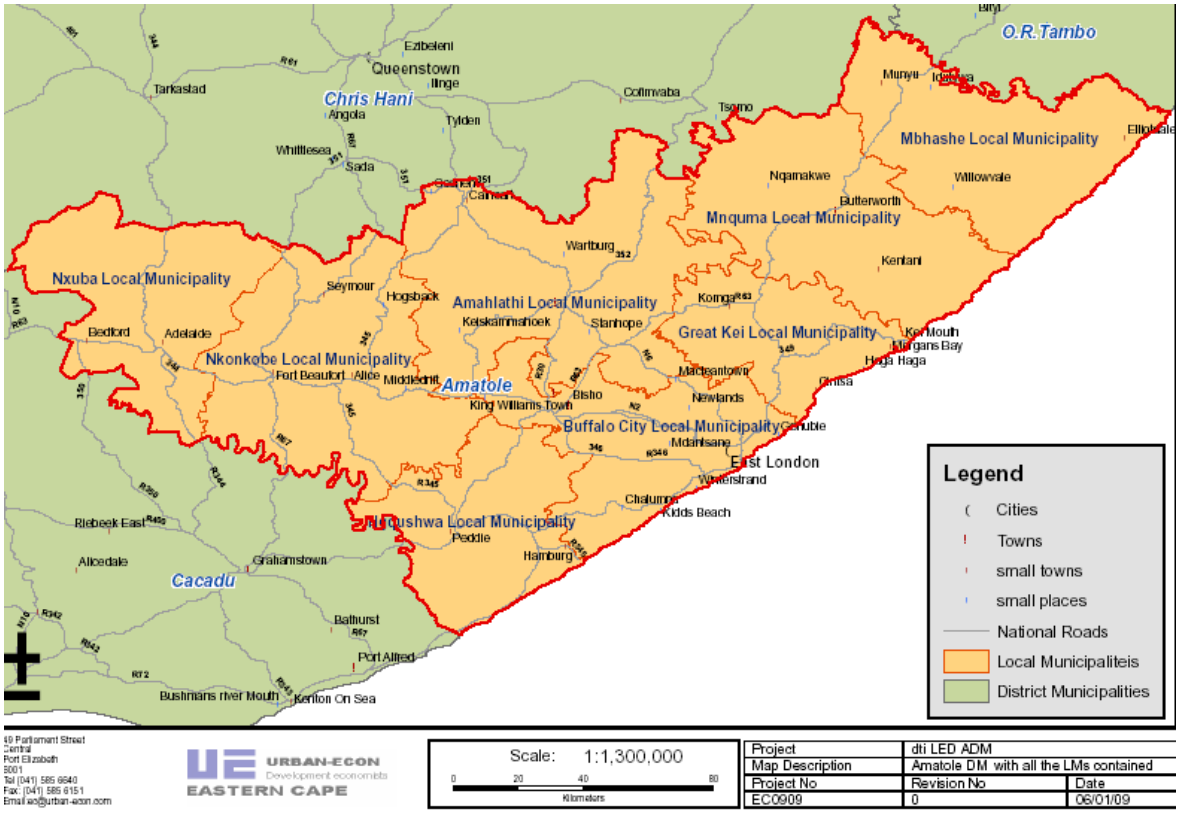


Figure 2: Map of the Amathole District Municipality (Source: *Urban-Econ Eastern Cape, 2009)*

As a result of these characteristics, this case could reveal insights to policymakers and other would-be change agents about the challenges of achieving knowledge flows between formal knowledge producers and the poor. In this context, the structural and behavioural factors that have been summarised in earlier sections are compounded by high levels of poverty, deprivation and marginalisation. It is in this context that the study wanted to probe conditions under which formal science and technology organisations can make a difference and be relevant.

4.3.2 Case Site 2: Dresden Village

Sekhukhune District Municipality (SDM) was established in December 2000. It consists of five Local Municipalities, namely Elias Motsoaledi, Ephraim Mogale, Greater Tubatse, Fetakgomo, and Makhuduthamaga. SDM is found in the Limpopo province, the northern-most part of South Africa.

It covers an area of approximately 13 264 square-metres - most of which is rural and it lies to the North West of Mpumalanga and the South of Limpopo. As shown in Figure 3, SDM is located outside major towns such as Pretoria at approximately 200km to the South, Nelspruit at about 150km to the East and Polokwane about 180km to the North. It is estimated that only 5 % of Sekhukhune population lives in urban areas.

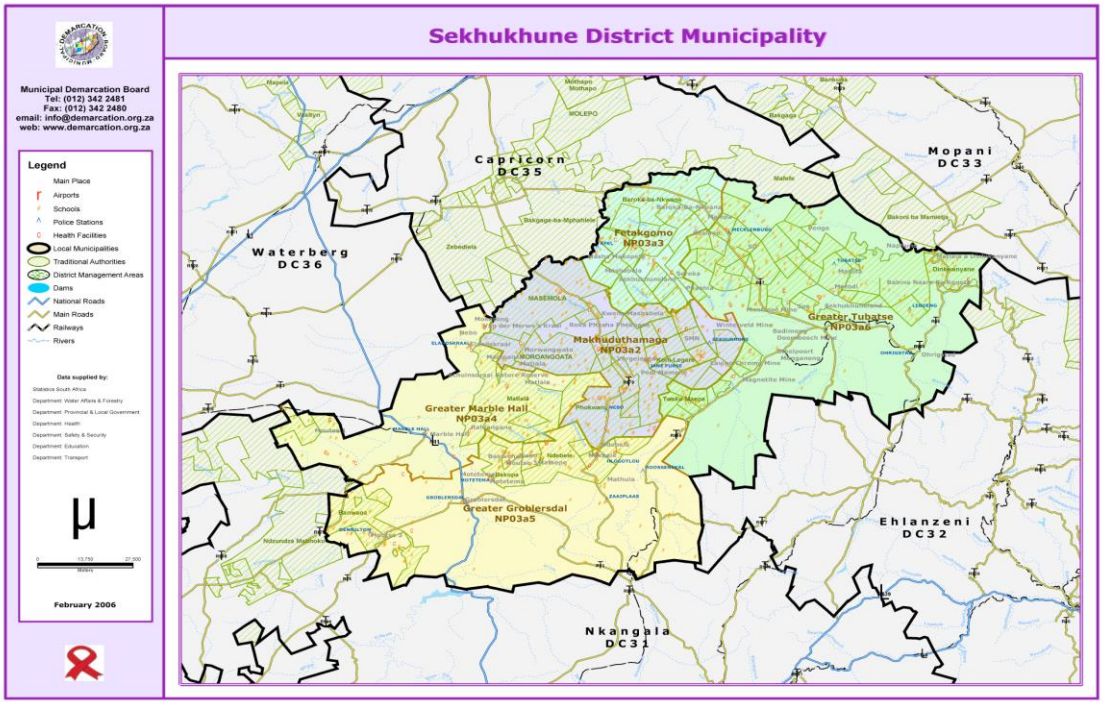


Figure 3: Map of the Sekhukhune District Municipality (Source: Municipal Dermacation Board, 2009)

The Sekhukhune District is mainly rural, with 94.7% of the total population residing in the rural areas and 5.3% in the urban areas. Given the nature of the rural economy, where economically active people migrate to cities, the majority of the population (56%) of Sekhukhune is youthful aged below 19 years of age. 38% represent part of the economically active group i.e. between 20 and 59 years while 6% are older than 60 years. Women constitute the majority of the population at 55.2%.

The main urban centres are Groblersdal, Marble Hall, Burgersfort, Jane furse, Ohrigstad, Steelpoort and Driekop. Outside these major towns, one finds almost 605 villages which are generally sparsely populated and dispersed throughout the District. The area's town and villages are serviced by its major rivers - the Olifants River, Tubatse River and the Elands River, all of which supply a number of large dams. The Sekhukhune economy is driven largely by agriculture, mining and tourism activities.

The total population of the SDM in 2011 was at 1,076, 840 (STATSSA, 2011). Half the respondents are below 18 years and the male to female ratio at this age is

equal whilst the female respondents represent 60% of the respondents over the age of 18 or the working age. The Sekhukhune economy is a curious mixture of overwhelmingly negative features such as the highest unemployment rate in Limpopo; and unbridled positive opportunities like the enormous mining potential within the area.

The population growth rate for the district was expected to drop to approximately 1% per year until 2008 and to increase slowly after that. This estimate is derived from the Bureau for Market Research at UNISA. This anticipated drop in population growth rates until 2008 is due to the HIV and AIDS pandemic.

As a result of these characteristics, this site provided a potentially rich source of data and insight about the challenges of achieving knowledge flows between formal knowledge producers and the poor. In this context, the structural and behavioral factors that have been summarised in earlier sections are compounded by high levels of poverty, deprivation and marginalisation. It is in this context that the study wanted to probe conditions under which formal science and technology organisations can make a difference through being socially relevant.

4.2. DEMOGRAPHIC PROFILE OF THE RESPONDENTS

This section presents the demographic profiles of the respondents in the two communities selected for the study.

4.2.1 Cwebe Village

The current sub-section presents the demographic profile of the respondents in the first community where a water provision project was established based on the S&T that was produced by the CSIR built environment operating unit.

All the 19 participants in the focus groups were community members who are above 18 years old and lived in Cwebe. The participants were all Africans and *Amathole* people of the *amaXhosa.* The focus group discussions were therefore all conducted in *isiXhosa* which is the spoken language in Cwebe. Of the participants 31.6% were members of the Water Task Team while 68.4% were Community

Members in Cwebe. This is illustrated in Figure 4.

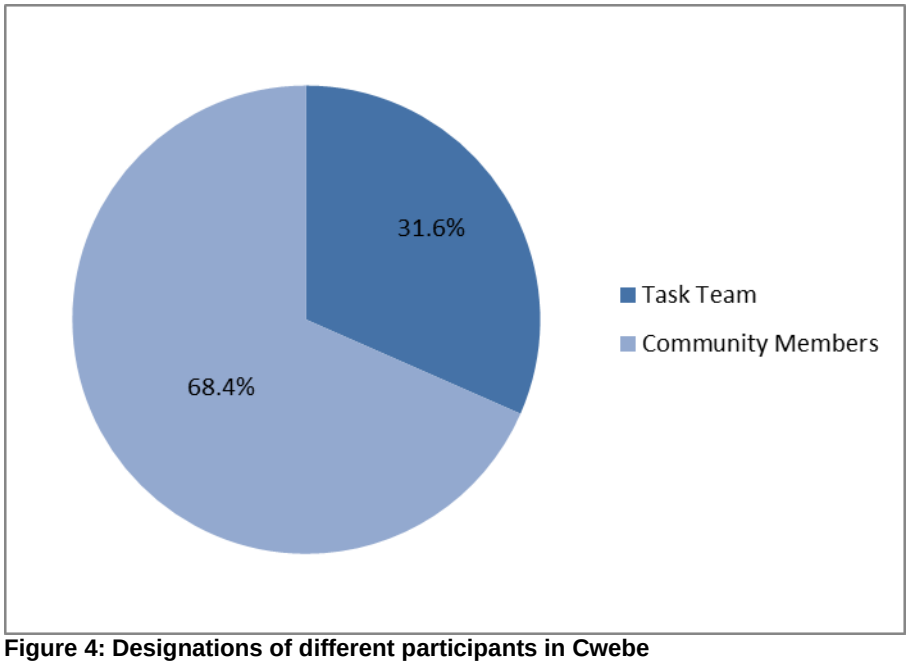


Figure 4: Designations of different participants in Cwebe

Of the participants 33% were members of the Water Task Team while 67% were Community Members in Cwebe. This is illustrated in Figure 5.

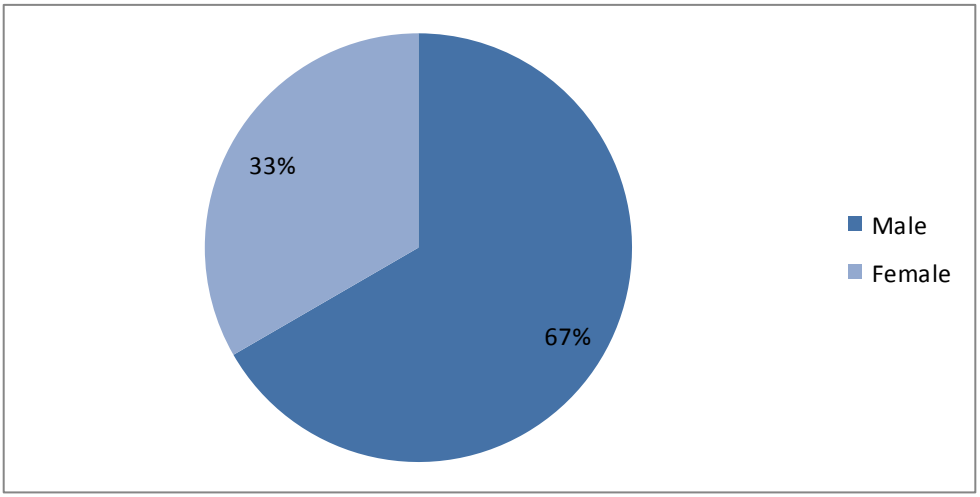


Figure 5: Demographics of the participants in Cwebe in terms of gender

The majority of the female participants had Standard 6 as their highest level of education. All participants had the highest level of education below matric and were unemployed. Details on the different levels of education of the female participants are indicated in Figure 6.

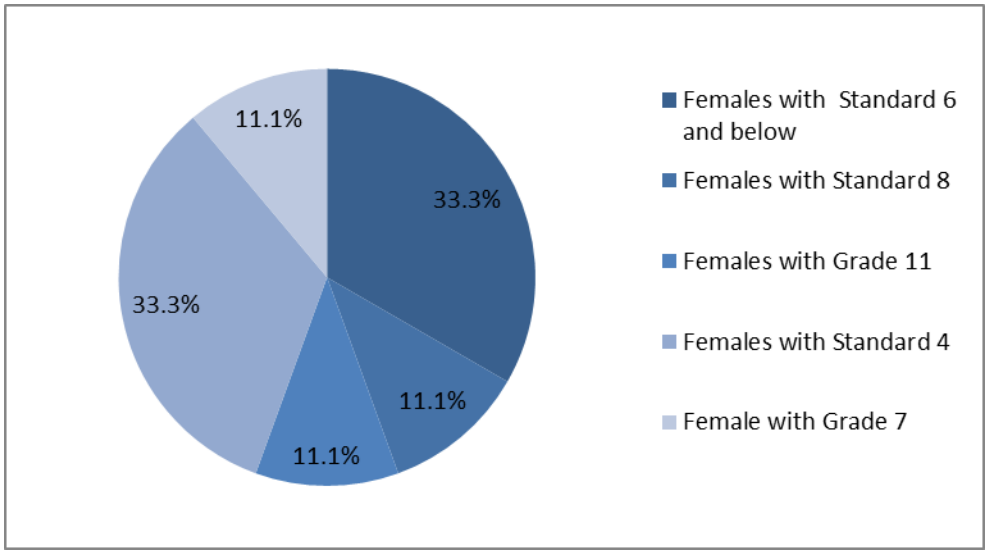


Figure 6: Demographics of female participants in Cwebe in terms of highest level of education

The majority of the male participants had Standard 6 and below. All participants had the highest level of education below matric and were unemployed. Details on the different levels of education of the male participants are indicated in Figure 7.

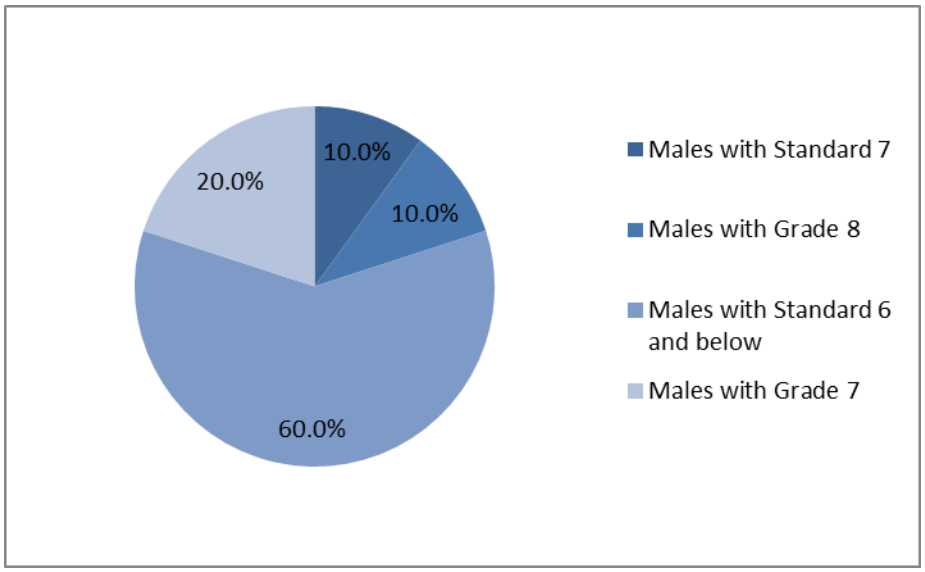


Figure 7: Demographics of male participants in Cwebe in terms of highest level of education

4.2.2 Dresden Village

In this section, I present the general profile of the participants in the first community where a project was established based on the S&T that was produced by the CSIR built environment operating unit.

All the 21 participants in the focus groups were community members who

are above 18 years old and lived in Dresden. The participants were all Africans and belong to the *Bapedi ba Ga-Sekhukhune* tribe. The focus group discussions were therefore all conducted in *Sepedi* which is the spoken language in Dresden. Of the participants 23.8% were members of the Water Task Team while 76.2% were Community Members in Dresden. This is illustrated in Figure 8.

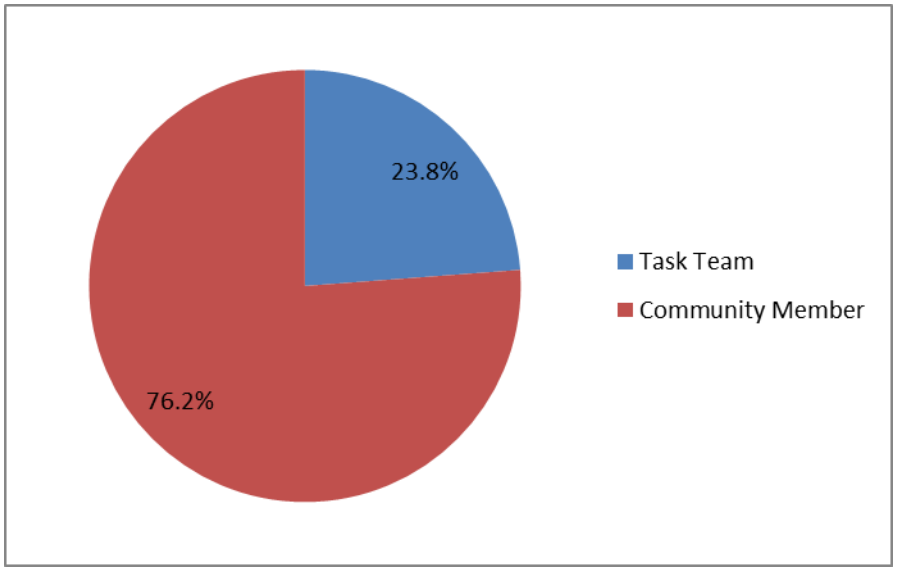


Figure 8: Designations of different participants in Dresden

It is also important to mention that the majority of the participants were females. Of the participants in this study, 42.9% were male while 57.1% were female. The demographics of the participants in terms of gender are indicated in Figure 9.

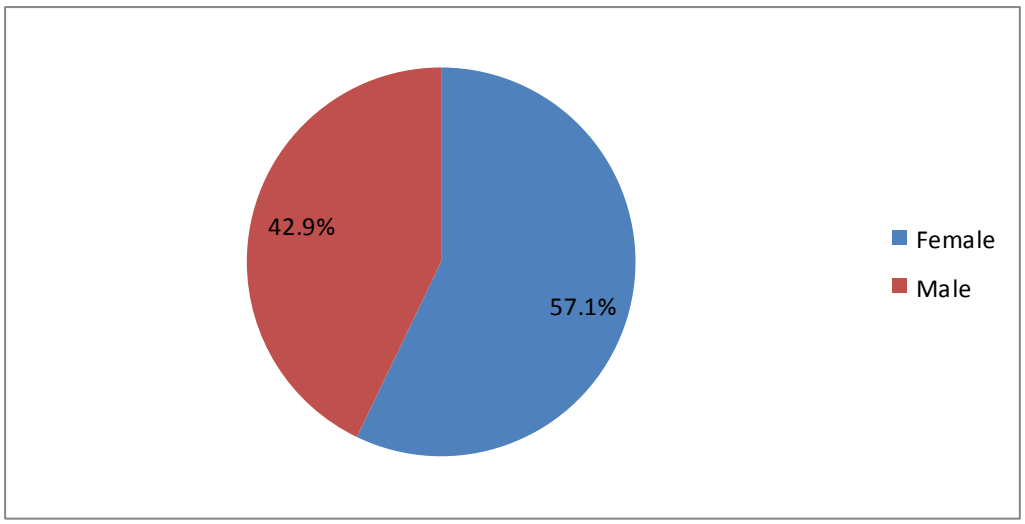


Figure 9: Demographics of participants in terms of gender in Dresden

The majority of the female participants had Grade 11 as their highest level of education. All participants except for one had the highest level of education below matric. Two of the participants hold National Certificate qualifications. The majority of the participants volunteered at the Dresden Home Based Care Centre while the other participants were unemployed. Details on the different levels of education of the female participants are indicated in Figure 10.

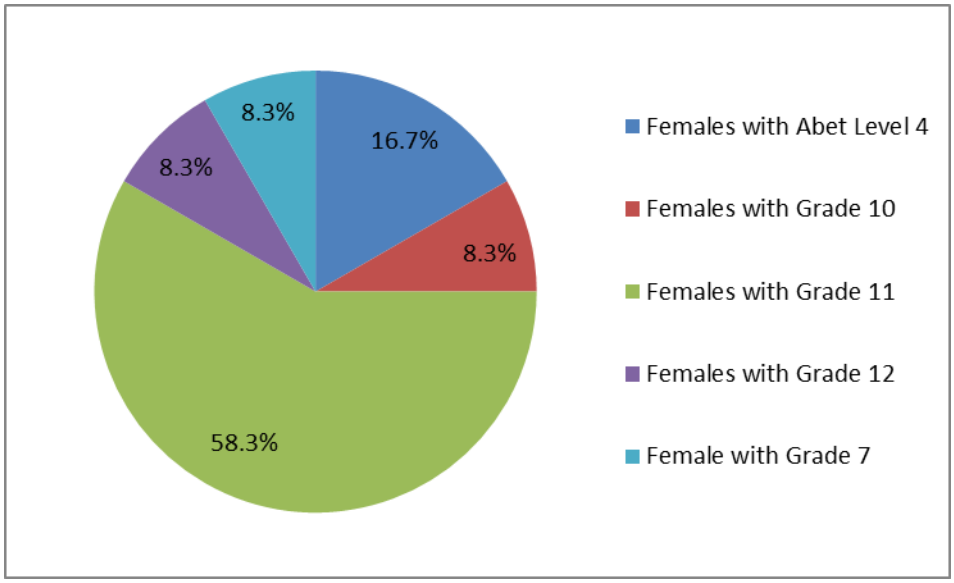


Figure 10: Demographics of female participants in Dresden in terms of highest level of education

The majority of the male participants had Standard 6 and below. However, of the male participants, 22.2 % of them had a National Certificate which is a post matric level qualification. Details on the different levels of education of the male participants are indicated in Figure 11.

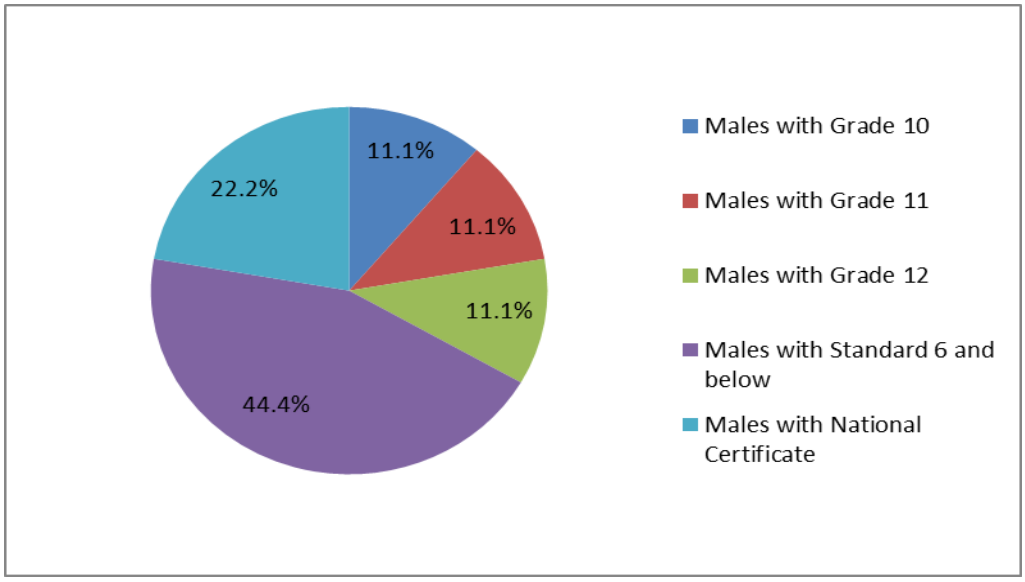


Figure 11: Demographics of male participants in Dresden in terms of highest level of education

4.2.3 Producers of Science and Technology

The researcher also interviewed producers of S&T, identified as such because they are involved in basic and applied scientific research and the development of technological artefacts with little or no input from the would-be users, at least in the initial stages. There is a well-known distinction in the national systems of innovation literature between users, producers and ultimately, user-producer interactions as a key driver of innovation (Lundvall 1992). Thus, these S&T producers included Researchers and S&T Managers employed by the CSIR. Details on the S&T producers who participated in the study are provided in Table 2 below.

Table 2: CSIR S&T Producers Participants

Respondent	Position/ Role	Project	Project Type
Respondent 1	Researcher	ASWSD II	Water provision
Respondent 2	Researcher	ASWSD I & II	Water provision
Respondent 3	Researcher	ASWSD I & II	Water provision
Respondent 4	Researcher	ASWSD II	Water provision
Respondent 5	R&D Management	R&D Management	Built Environment
Respondent 6	Stakeholder Relations Management	R&D Management	Built Environment

*ASWSD - Accelerating Sustainable Water Services Delivery

4.3 PROJECT BACKGROUND INFORMATION

This section presents the project background information for the two communities selected for the study.

All participants in Cwebe agreed that the water provision project was the only development project that was carried out in Cwebe over the past three years. In Dresden all participants agreed that there had been a number of community development projects that were carried out in Dresden within the past three years. The proportion of community development projects that were carried out in Dresden within the past three years is indicated in Figure 12.

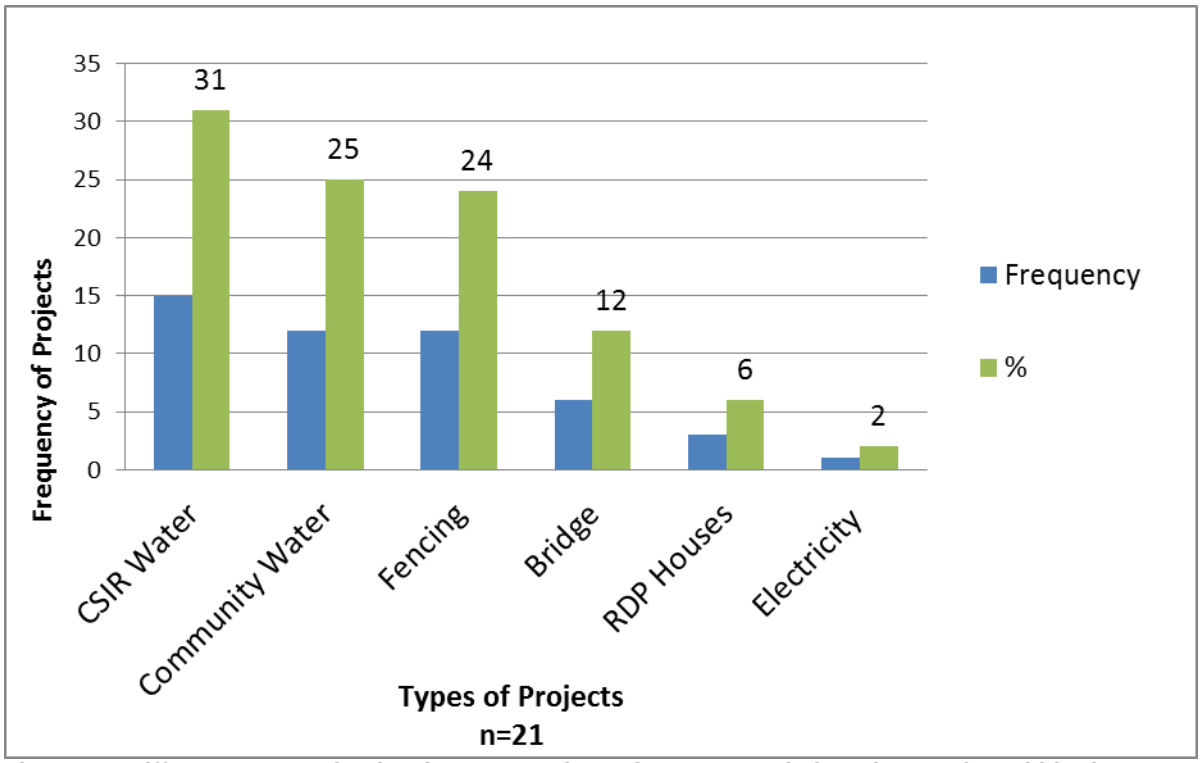


Figure 12: Different community development projects that were carried out in Dresden within the past three years

Of the participants, 31% highlighted the CSIR Water Provision project as one of the community development projects that were carried out in Dresden within the past three years. This was followed by the Community water project at 25%. Other projects that were not related to water provision were also mentioned. This is indicated in Table 3.

Table 3: Community development projects that were carried out in Dresden within the past three years (n=21)

Project	Frequency	Relative Frequency	%
CSIR Water	15	0.31	31
Community Water	12	0.25	25
Fencing	12	0.24	24
Bridge	6	0.12	12
RDP Houses	3	0.06	6
Electricity	1	0.02	2
Total	49	1	100

All Researchers and R&D Managers agreed that they had directly been involved in or participated in one or more water provision projects handled by the CSIR Built Environment unit. Details of the two main projects and the involvement of the different participants in the specific projects are highlighted in Table 1 in Chapter 3 of this report.

4.4 POWER DYNAMICS

This section presents data in relation to the issues of project decision making powers and in the two communities selected for the study.

All participants in Cwebe agreed that the scope of the CSIR Water Project was to ensure access to clean water by the residents of the Amathole District Municipality. The respondents further agreed that with regards to the water provision project in Cwebe, its timing and scope were decided on by the Municipality, HSRC and the CSIR. A proportion of the understanding of the participants on what was the actual scope of the CSIR Water project in Dresden is indicated in Table 4.

Table 4: Understanding of CSIR Water Project scope in Dresden (n=21)

Project Scope	Frequency	Relative Frequency	%
Bringing water closer to homes	6	0.67	67
Clean water distribution	3	0.33	33
Totals	9	1	100

As indicated in Table 3 above, 67% of the participants viewed the scope of the CSIR Water project to have brought water closer to the homes, while the remaining 33% said it was about clean water distribution.

All participants agreed that the scope of the CSIR Water Project in Dresden was both to provide clean water to the community as well as ensuring that all community members had closer access to water.

4.4.1 Project Decision Making

Figure 13 indicates the views of the respondents in Dresden on how the CSIR Water project and its scope were decided upon in Dresden. The graph reveals that 60% of the respondents said the CSIR Water projects and its scope were decided on based on the Municipal Decision, 27% of the respondents mentioned that it was as a result of the Community initiative, while 13% said it was based on the discussions between the Municipality and the CSIR.

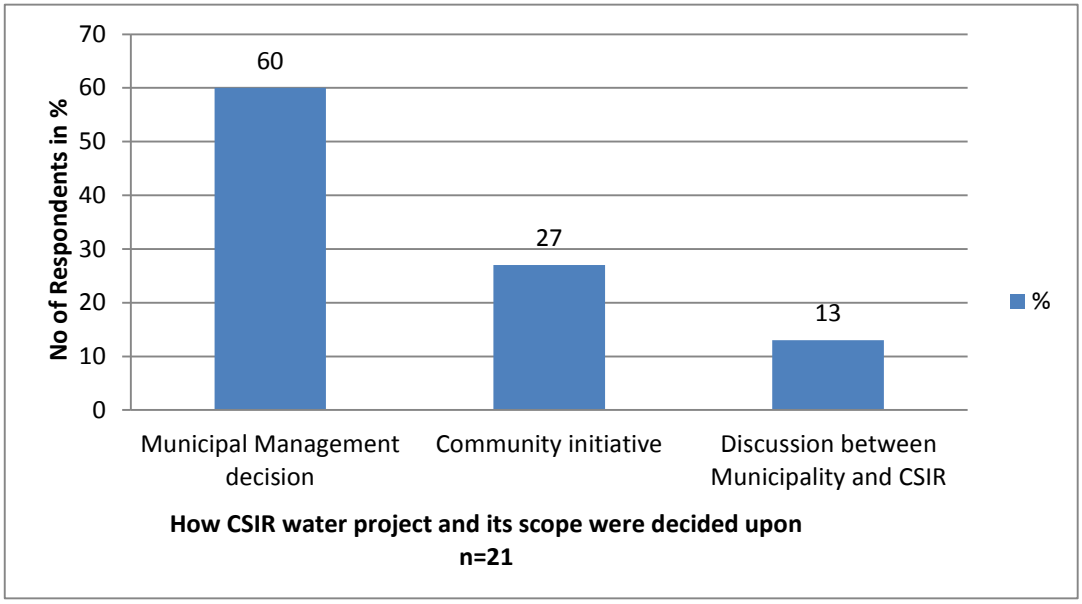


Figure 13: How CSIR Water Project and it scope were decided upon in Dresden

The view of the participants on how the CSIR water project came about in Dresden is indicated in Figure 14.

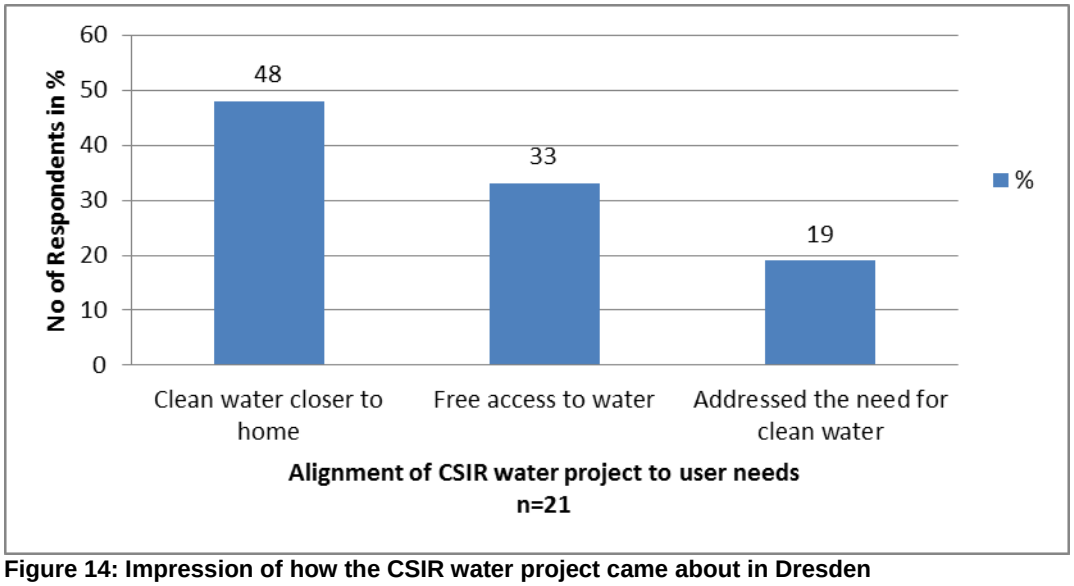


Figure 14: Impression of how the CSIR water project came about in Dresden

Sixty-seven percent of the respondents mentioned that the CSIR water project was decided upon by the Municipal Management, while 33% of the respondents said it came about as a result of the discussions between the Municipality and the CSIR.

The view of the participants on who decided on the type of project and its timing in

Dresden is indicated in Figure 15. Sixty-seven percent of the respondents mentioned that the type of projects as well as their timing was jointly decided upon by the Municipal Management and the District Office, while 33% of the respondents said that these were decided upon through agreements between the Municipality and the funders.

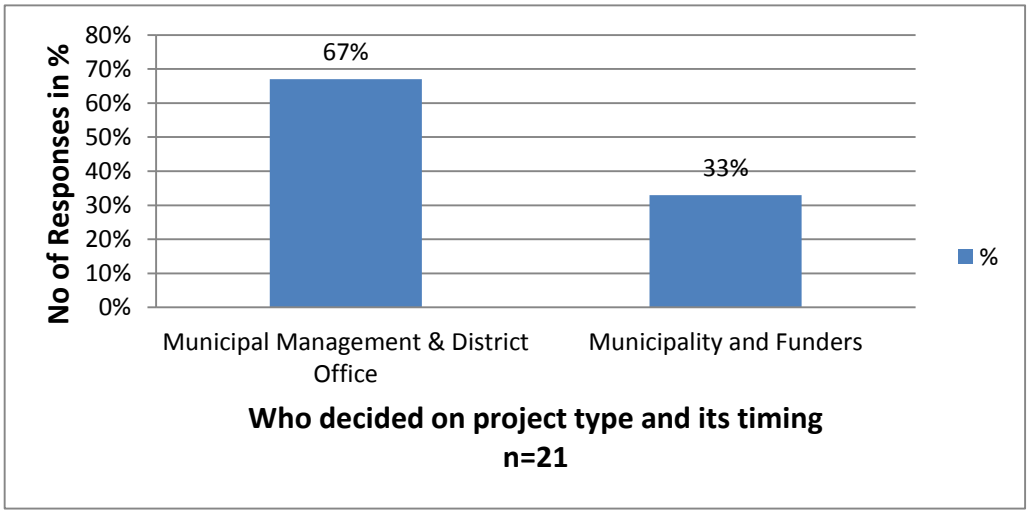


Figure 15: Who decided on project type and its timing in Dresden

All participants in Cwebe agreed that the CSIR water project came about as a result of the Cholera outbreak in the Amathole District municipal area. They indicated that the Department of Health informed the Municipal Management about the outbreak, and they subsequently called the HSRC to come and assist with finding solutions to the problem. The respondents also agreed that the CSIR came to work on the water provision project in Cwebe upon invitation by the HSRC.

The producers of S&T confirmed that the decision making powers were in the hands of their clients. They claimed that the clients would specify their needs and the CSIR would provide solutions based on S&T within the project scope as defined by the clients' specifications. At the same time, the needs of users are decided upon and solutions provided based on the clients' briefing which could not have necessarily been what the people express as their needs. Solutions are developed *for* the people and not *with* them to ensure relevance.

4.4.2 Project Decision Making Processes

All participants in Cwebe agreed that the water project was decided upon in response to the cholera outbreak in the area. They all agreed that they did not know anything about the project decision making process.

Data on how the water project came about in Dresden is indicated in Figure 15. The graph reveals that 44% said the water project was initiated as a result of the demand by community members in exchange for participation in the 2011 Municipal Elections; while 30% of the respondents stated that the Water committee was only involved at the project implementation phase after the project and its scope had been decided upon. The remaining 26% of the respondents mentioned that project decisions were taken by the Municipal Management.

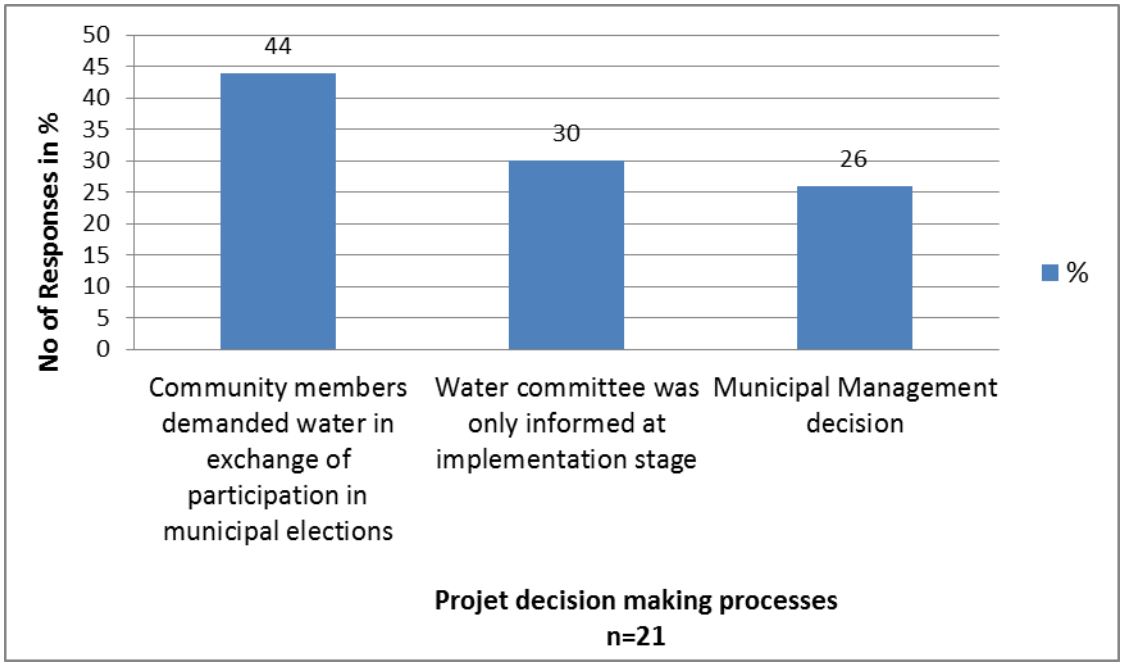


Figure 16: Project decision making processes in Dresden

4.4.3 Stakeholder Involvement in the Project

The roles played by each of the stakeholders who were involved in the CSIR Water project in Cwebe as per the respondents are indicated in Table 5. A total of 5 stakeholders were highlighted as having played a role in the CSIR Water Project in Cwebe. These include the Tribal Authority, Department of Health, Municipal

Management, HSRC, CSIR, as well as a Task Team.

Table 5: Stakeholders involved in the CSIR Water Project in Cwebe

Stakeholders	Roles Played in the Project
Department of Health	Informed the Municipal Management of the Cholera outbreak in the district
Municipal Management	Invited the HSRC to come and investigate the problem and give advice on the relevant solution
CSIR	Project implementation
Task Team	Coordination of activities
Tribal Authority	Gave permission for the stakeholders to work in the village

The roles played by each of the stakeholders or actors who were involved in the CSIR Water project in Dresden as articulated by the respondents are indicated in Table 6.

Table 6: Stakeholders involved in the CSIR Water Project in Dresden

Stakeholders	Roles Played in the Project
Community Members	Water distribution initiative
Municipal Management	Stopped the community initiative and gave the project to the CSIR
District Office	Supplied *JoJo* tanks
CSIR	Project implementation
Water Committee	Liaison between municipal management and tribal authority
Task Team	Coordination of activities
Tribal Authority	Gave permission for the community initiative

A total of 7 stakeholders were highlighted as having played a role in the CSIR Water Project in Dresden. These include the Tribal Authority, Community Members, Municipal Management, District Office, CSIR, Water Committee, as well as a Task Team.

All the researchers who participated confirmed that the users and stakeholders

were only involved in projects during the implementation phase. This would commonly be when water committees and task teams are appointed to facilitate the project implementation processes.

The S&T Managers did not comment on the issue of decision making as they reported that they often engaged with Researchers and clients, but did not know if users were involved in the scoping of projects. They claimed that stakeholder involvement was assured by undertaking S&T projects that adhered to CSIR's mandate in terms of contributing to the improvement of the lives of the people of South Africa.

4.5 PROJECT FUNDING

This section presents data on the issues of project funding of the projects in the two communities selected for the study.

4.5.1 Sources of Funding

All participants agreed that the water project in Cwebe was externally funded. They indicated that the HSRC got the CSIR to come with funds and implement the project in Cwebe.

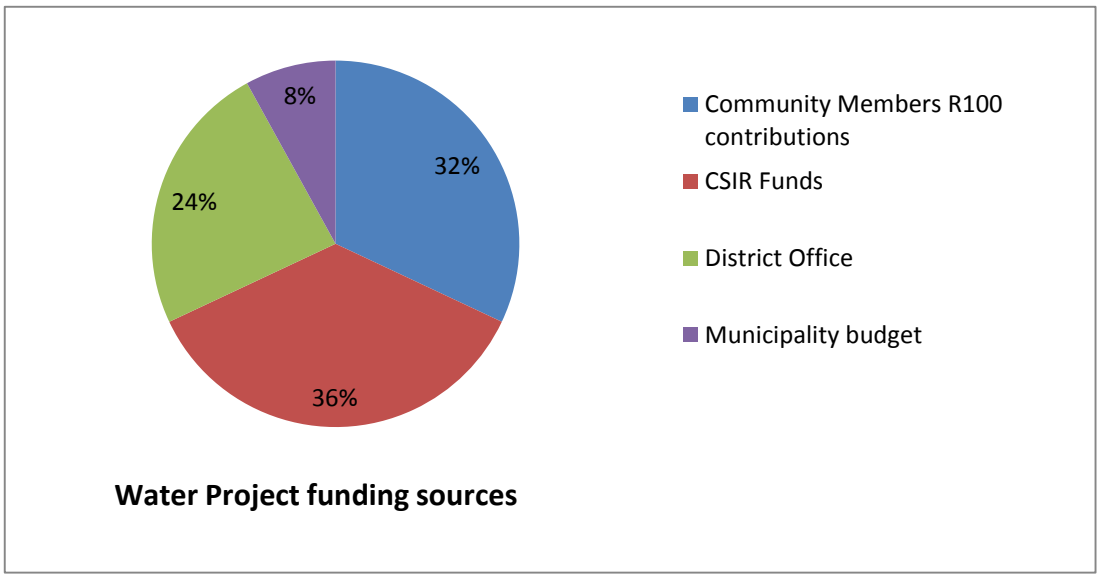


Figure 17: Water Project funding sources in Dresden

Proportions of how the water project was funded in Dresden are indicated in Figure 17. The pie chart above indicates that 36% of the respondents viewed the CSIR as the main funder followed by the R100 contributions by community members with 32% responses. Details of other sources of funding mentioned were the District office and the Municipality budget.

The participating researchers agreed that project funders were often the clients. The ASWSD I&II projects in particular were funded by the DST.

4.5.2 Funding Conditions

All participants agreed that they did not know of any conditions that were attached to the funding provided for the water project in Cwebe.

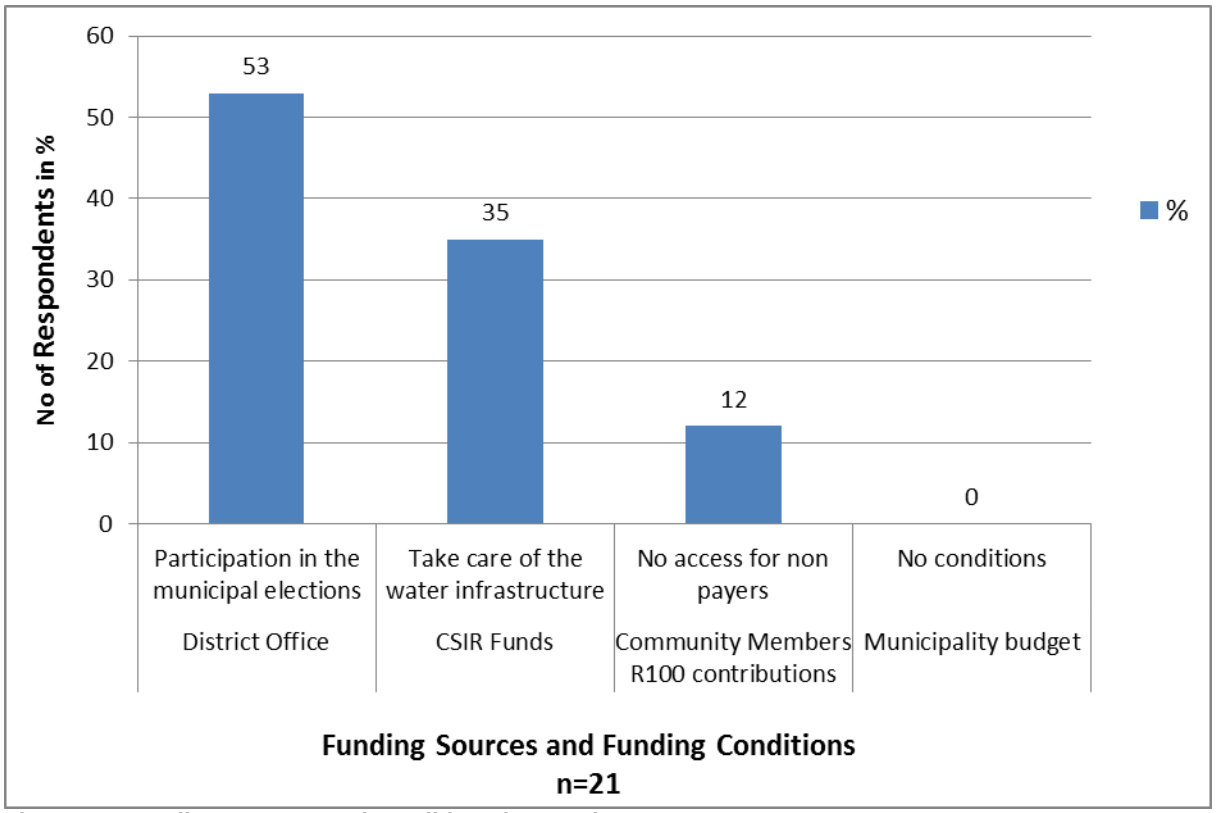


Figure 18: Funding sources and conditions in Dresden

As indicated in Figure 18 above, the community members in Dresden agreed that those who did not contribute the R100 would not be given access to the water. Of the total respondents, 35% indicated that the CSIR expected the community to

take care of their water infrastructure. While the participants did not indicate any funding conditions for the Municipality budget, 53% of the respondents indicated that the District Office provided funding for the water project on condition that the community members would participate in the municipal elections in 2011.

According to the Researchers and S&T Managers who participated in the study, there were no funding conditions. The participants agreed that projects were required to deliver on quality S&T based projects that would help improve the quality of life for the people of South Africa.

4.5.3 Ensuring Value for Money in Project Investment

Respondents in Cwebe indicated that they did not see any efforts made to ensure value for money in the water project. They indicated that on the contrary they noted a lot of waste of resources.

Figure 19 indicates that two ways for ensuring value for money were identified in terms of the water project. The majority of the respondents agreed that value for money in the water project is ensured through liaison with the municipal management (with 60% responses); while 40% indicated that infrastructure issues were resolved through the facilitation of the water committee.

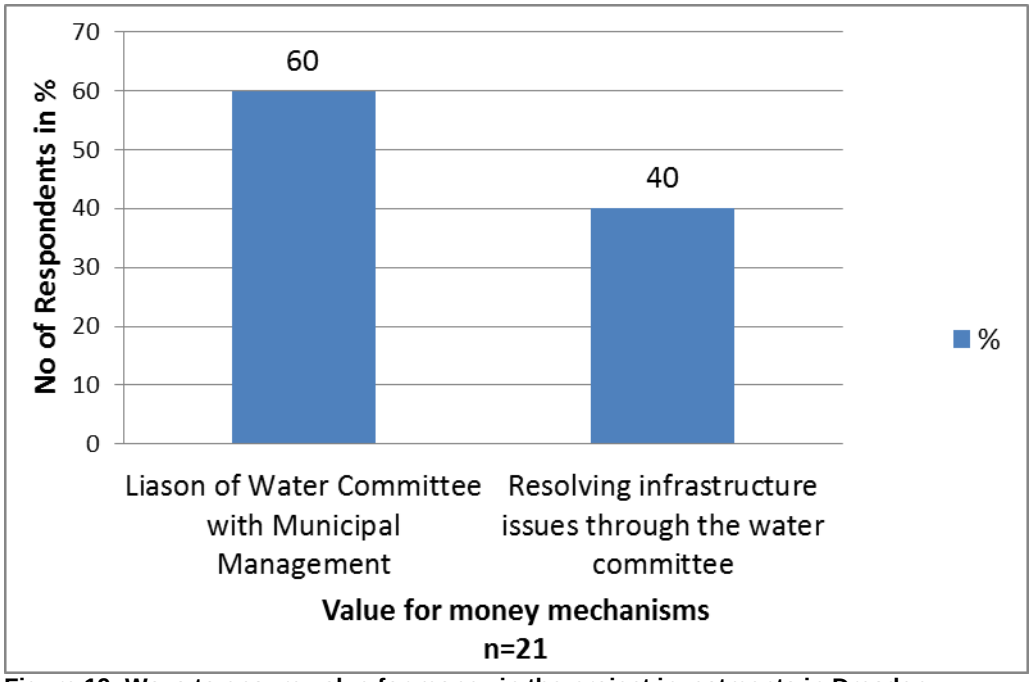


Figure 19: Ways to ensure value for money in the project investments in Dresden

The CSIR researchers suggested that value for money was ensured by producing quality S&T per the clients' brief, within budget, and on time. They further mentioned that the value was also realised in the improved living conditions of the users once projects had been implemented in their communities.

4.6 USER INVOLVEMENT IN SCIENCE AND TECHNOLOGY PROJECTS

This section presents data on the involvement of users in S&T programmes.

4.6.1 Alignment of CSIR Water Project with User Needs

Figure 20 indicated that all participants in Cwebe agreed that the CSIR Water project was aligned to their need for drinking water as users. Of the respondents, 26% said that the project addressed the need for drinking water in Cwebe, 31% indicated that the project resulted in the availability of clean water in the community. The majority of the respondents, at 43% indicated that the project brought clean water to their homes when the communal water station was functional.

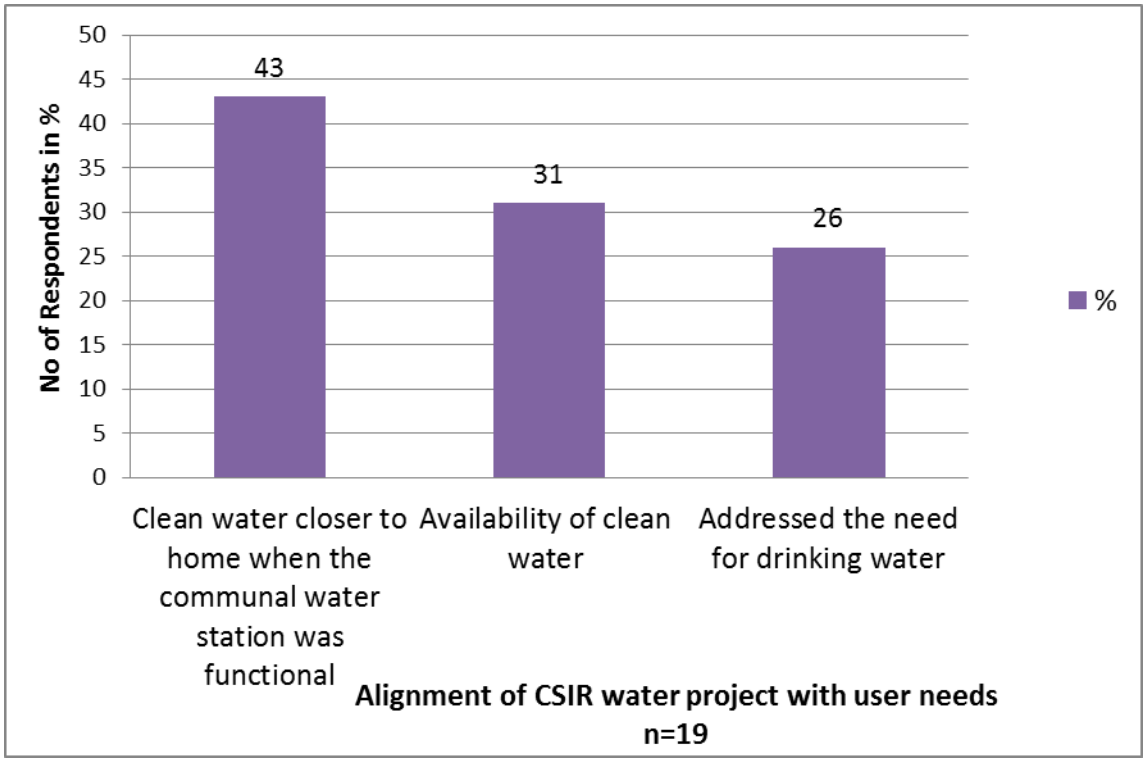


Figure 20: Alignment of CSIR water project with user needs in Cwebe

Figure 21 indicates that the participants in Dresden agreed that the CSIR Water project addressed their needs as users. Of the respondents, 48% said that the project brought clean water closer to their homes, 33% said they got free access to water, and 19% said their need for clean water was addressed.

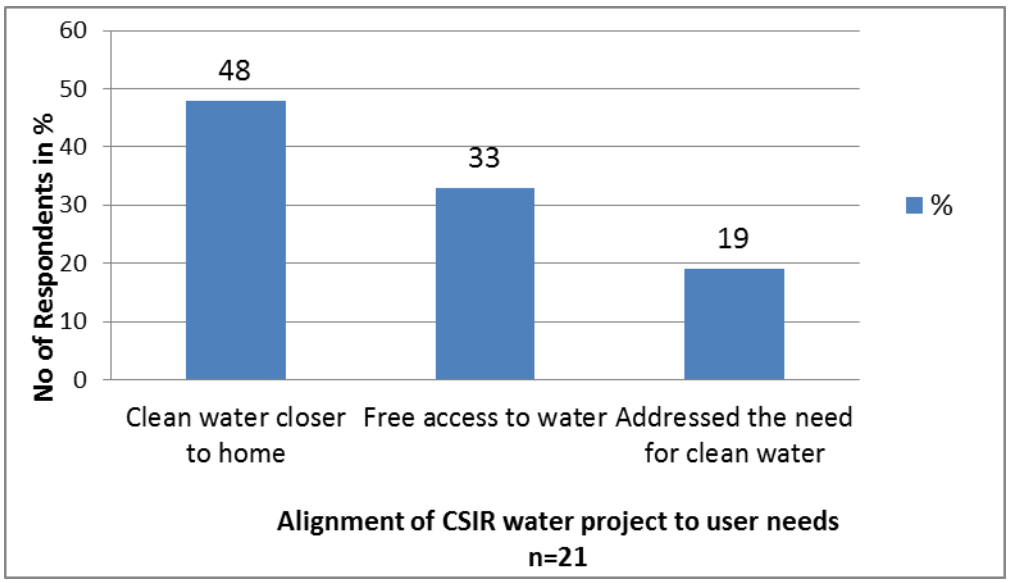


Figure 21: Alignment of CSIR Water project with user needs in Dresden

Both S&T managers agreed that the main issue of concern was the impact that projects would have. The researchers agree that the water projects contributed to improved quality of life of users as they addressed an important basic human need, which is water.

4.6.2 Alignment of S&T Programmes with the Needs of Users

Figure 22 indicates the views of participants in Cwebe on the alignment of work delivered through projects with the needs of the users. Of the respondents, 42% mentioned that actions were only taken to address the needs of users in crisis situations. Thirty-two of the respondents indicated that the municipality only delivered services as a form of electioneering. The other 26% indicated that efforts were made to genuinely address the need for drinking water within the community.

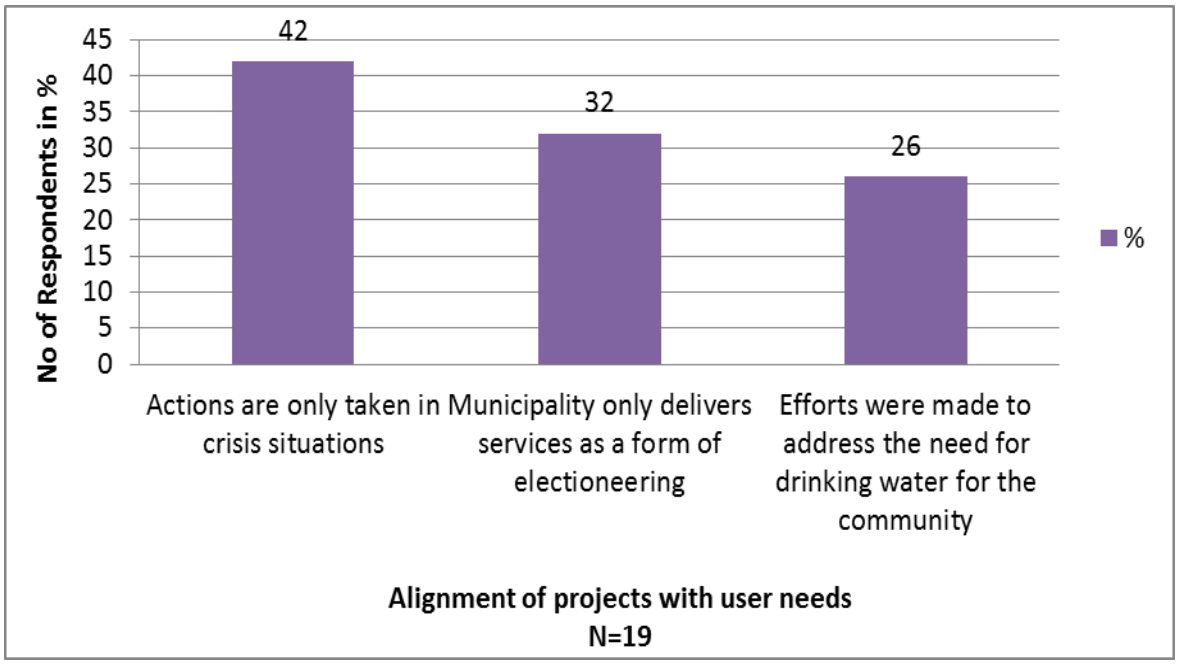


Figure 22: Alignment of project with user needs in Cwebe

Figure 23 indicates the views of participants in Dresden on the alignment of work delivered through projects with the consideration of the needs of the users. 37.5% of the respondents mentioned that the needs of the users were considered; the other 37.5% said that it was only some of the projects that addressed the needs

the users. While another 25% of the respondents agreed that the needs of the users were considered, they also said the priorities of users were not addressed.

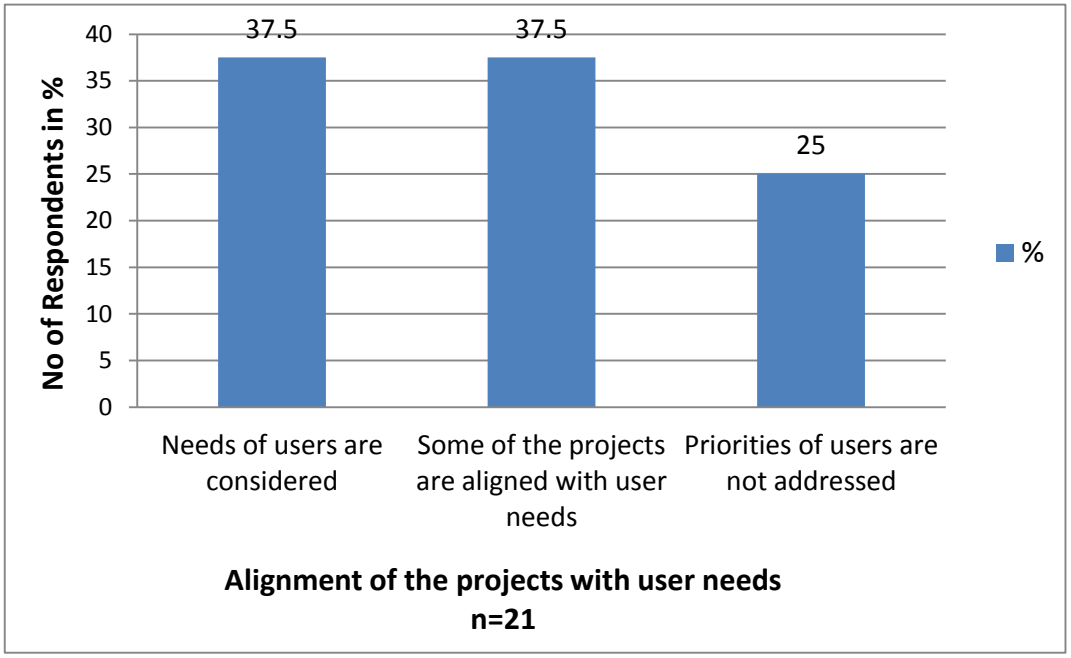


Figure23: Alignment of projects with user needs in Dresden

All the participating producers of S&T agreed that the ASWSD I & II projects were funded by the Department of Science and Technology (DST). They reported that DST made the funds available to the CSIR BE unit to demonstrate how to expedite the provision of reliable safe drinking water (potable water) to underserviced or unserved communities living in remote rural areas through the application of science and technology. Aligned with the CSIR mandate, the projects would improve the quality of life of the users by ensuring that they have access to clean water based on technologies that are best suited to their context. In this way value for money in the project investments would be realised. The researchers reported that the projects were initiated based on the requirements of the funders and they had the opinion that this ST eventually addresses the needs of the users as water is one of the basic human needs.

4.6.3 Project Contribution to the Improvement of the Quality of Life of Users

The participants in Cwebe agreed that consideration was made on how the project would support their quality of life as users. All respondents indicated that the municipality made efforts to address a problem that affected the quality of life for the community in order to make sure that their quality of life was improved.

There was an agreement by participants in Dresden that consideration was made on how the projects would support their quality of life as users. All respondents indicated that the municipality looked at what they saw as a need for the community in order to make sure that the projects support the users' quality of life. The respondents in Dresden indicated that the projects were based on the requirements and specifications of the clients who were also funders. They further claimed that with most of the clients being government departments, it was often part of their mandate to contribute to the improvement of the quality of life of the people of South Africa as it was the case for the CSIR.

4.6.4 Extent of Understanding of User Expectations

The data presented in Figure 24 shows that 71% of the respondents agreed that CSIR understands user expectations while 29 % did not. Of the 71 %; 14 % claimed that CSIR takes too long to deliver and 57% indicated that CSIR does not work according to the priorities of community members. Of the 29 % respondents; 10% said that the CSIR worked based on their own internal research and 19% said they worked based on their agreement with the municipal management.

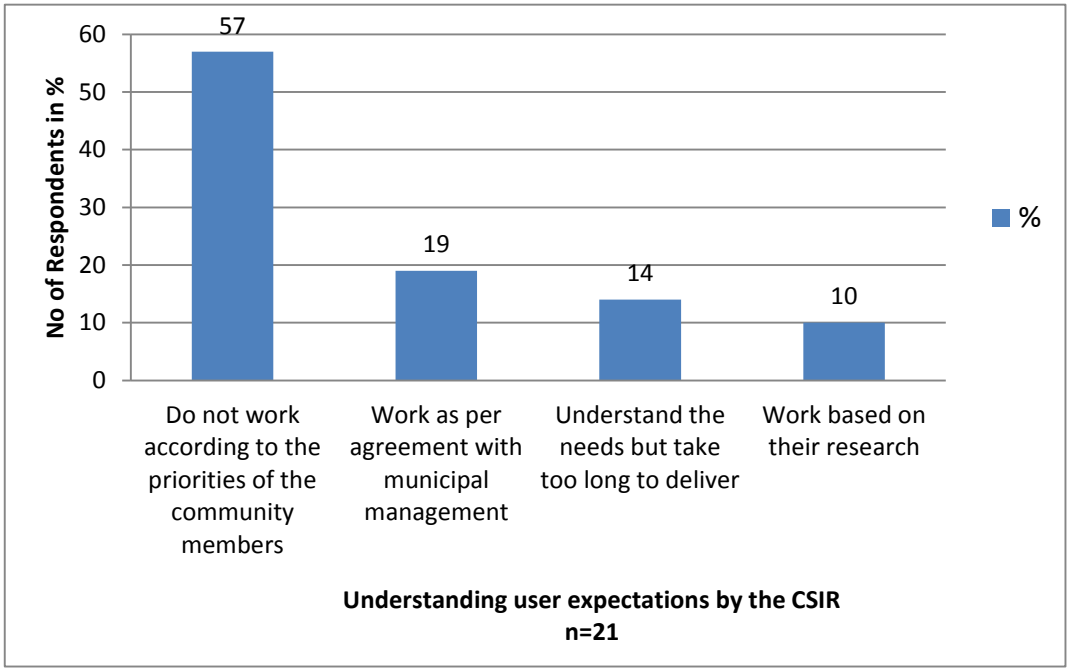


Figure 24: Understanding of user expectations by the CSIR in Dresden

The respondents in Cwebe agreed that the CSIR understands the expectations of the users as they do work that addresses the needs of users like bringing clean water to the community.

There were agreements by participants both in Cwebe and in Dresden that it is very important for the CSIR to understand the expectations of the users of their technologies; as well as to deliver on the expectations of these users.

All researchers agreed that they present the CSIR to users as an organisation that assist with water provision using science and technology. They agreed that while it is important for the CSIR to understand the user expectations, S&T projects are delivered based on contractual agreement with the clients.

4.6.5 Managing user expectations by the CSIR

The researchers agreed that they always explained their contractual obligation to the users while appreciating their expectations. They reported that they consistently requested the cooperation of users in projects as per the project scope and deliverables. All focus groups agreed that the CSIR delivered projects according to project scope, within budget, as well as within the agreed time frame

and not as per user expectations.

4.7 KNOWLEDGE AND UNDERSTANDING OF THE CSIR BY USERS

The participants both in Cwebe and in Dresden acknowledged that they knew about the CSIR. The actual description of CSIR for Cwebe is shown in Figure 25. Of the respondents, 56% said CSIR is a company that provides water to communities and 16% said it is company that works on community projects. The remaining 28% said it is a water company.

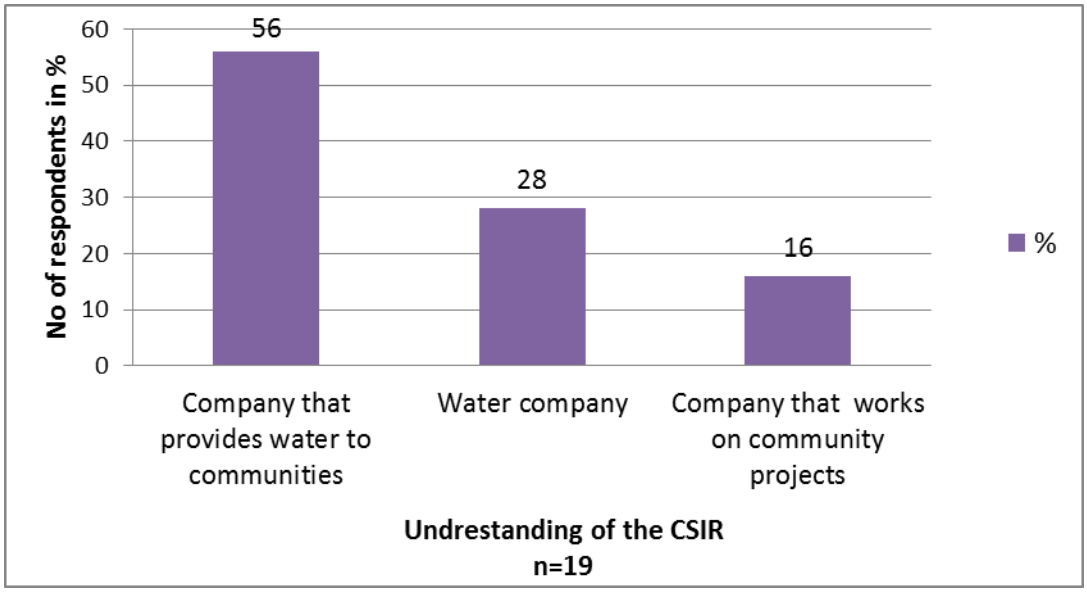


Figure 25: Understanding of the CSIR by the users in Cwebe

The participants' understanding of the CSIR in Dresden is indicated in Figure 26. Of the respondents, 38% said CSIR is a self-funded company that provides water to communities and 29% said it is an independent company that does projects in communities. The graph also indicates that 19% said the CSIR does research on making water available to communities; while the remaining 14% said it is a company that provides water.

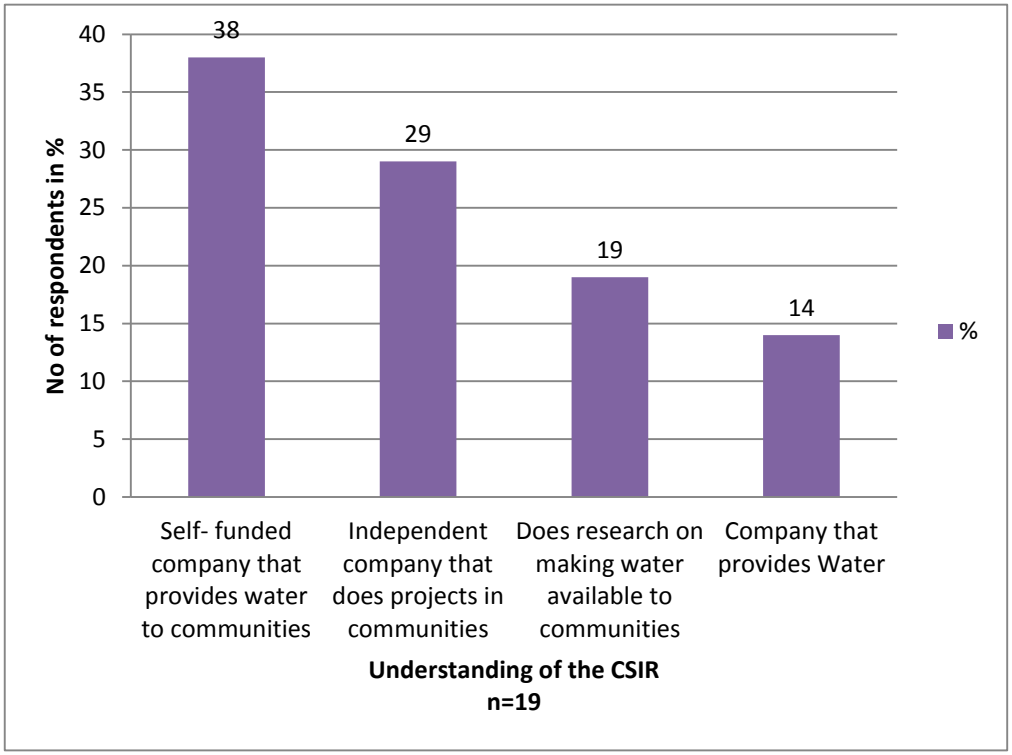


Figure 26: Understanding of the CSIR by the users in Dresden

4.8 OVERALL RELEVANCE

This section presents data on the overall social relevance of S&T programmes in the two communities selected for the study.

4.8.1 Determining Relevance of S&T

The views of the respondents in Cwebe on how relevance of S&T projects can be ensured, is indicated in Figure 27. The graph indicates that 24% of the respondents said it is important to ask the community what their needs are. The remaining 76% said it is important to address all the needs and not only one such as water provision.

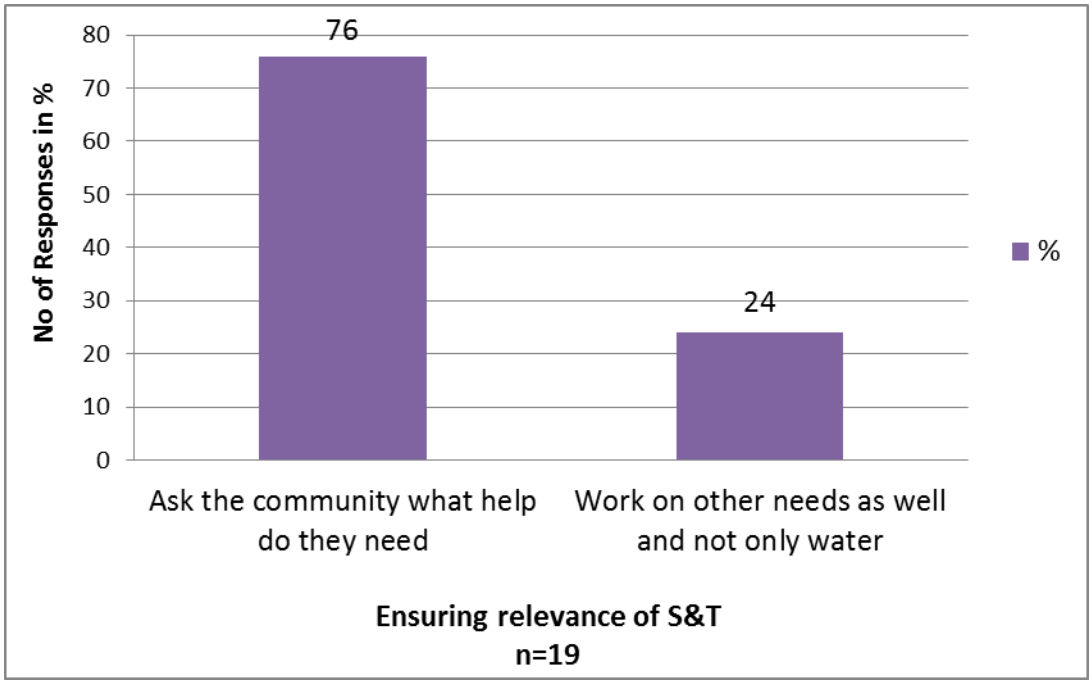


Figure 27: How relevance of S&T work can be ensured according to participants in Cwebe

The views of the respondents in Dresden on how relevance of S&T projects can be ensured, is indicated in Figure 28. The graph indicates that 33% of the respondents said it is important to check with the users what their needs were. The remaining 67% said it is important to check with the users what their pressing needs were.

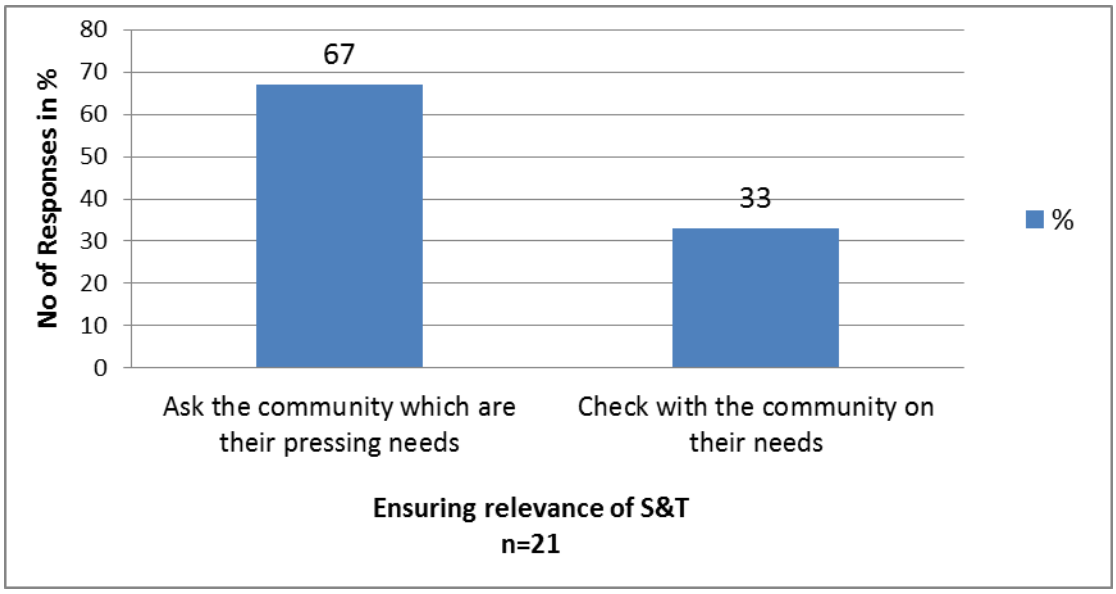


Figure 28: How relevance of S&T work can be ensured according to participants in Dresden

4.8.2 Relevance of the CSIR Built Environment Unit Work to Social Needs

All respondents in Cwebe agreed that CSIR work was relevant to their social needs. Figure 28 indicates that 47% of the respondents in Dresden agreed that CSIR work was relevant to social needs. The graph also shows that 43% of the respondents said that delivery took too long, whereas 10% said that other priorities should have been addressed first.

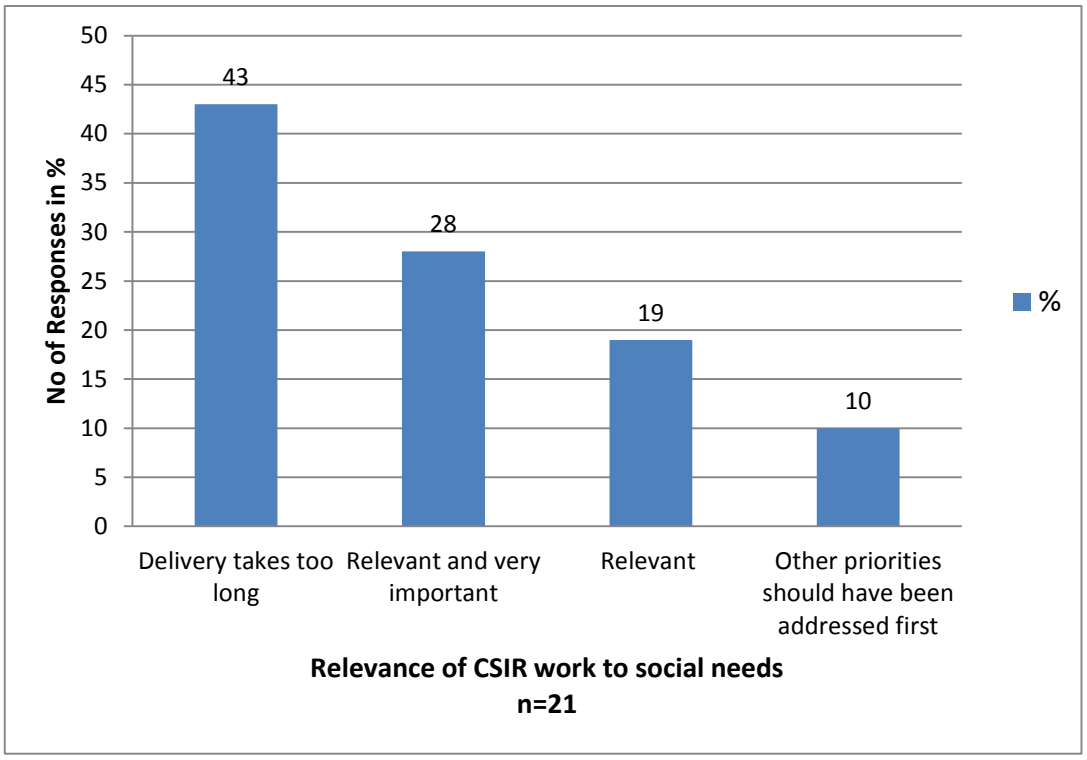


Figure 29: Relevance of CSIR Built Environment unit work according to participants in Dresden

4.8.3 Contradictions between User Expectations and Requirements of Research Funders

The participants in Cwebe indicated that they were not aware of any contradictions between user expectations and expectations of research funders. They further indicated that some of their needs were often left unattended even after they had been asked to express their needs.

All participants agreed in Dresden that there were often contradictions between user expectations and expectations of research funders. The participants further

indicated that contradictions between user expectations and expectations of research funders were not adequately dealt with.

4.8.4 The Effect of Development Projects on the Quality of Life of Users

Figure 30 indicates that 63% of the respondents in Cwebe agreed that CSIR work improved their living conditions. Thirty-seven percent of the respondents indicated that the improvements were however short-lived as there were challenges with the maintenance of the water facilities in Cwebe.

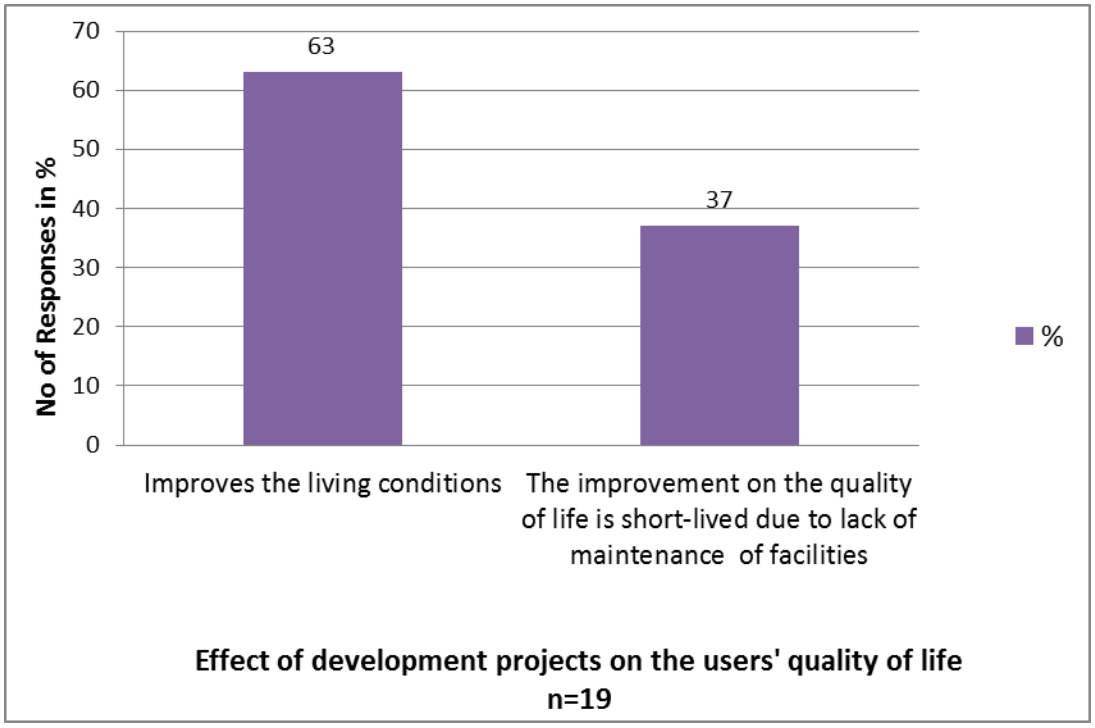


Figure 30: The effect of development projects on the quality of life of users in Cwebe

Figure 31 indicates that 47% of the respondents in Dresden agreed that CSIR work improved their living conditions. The graph also shows that 35% of the respondents said that the work made their lives better, whereas 18% said that the project caused divisions in the community due to how it was handled.

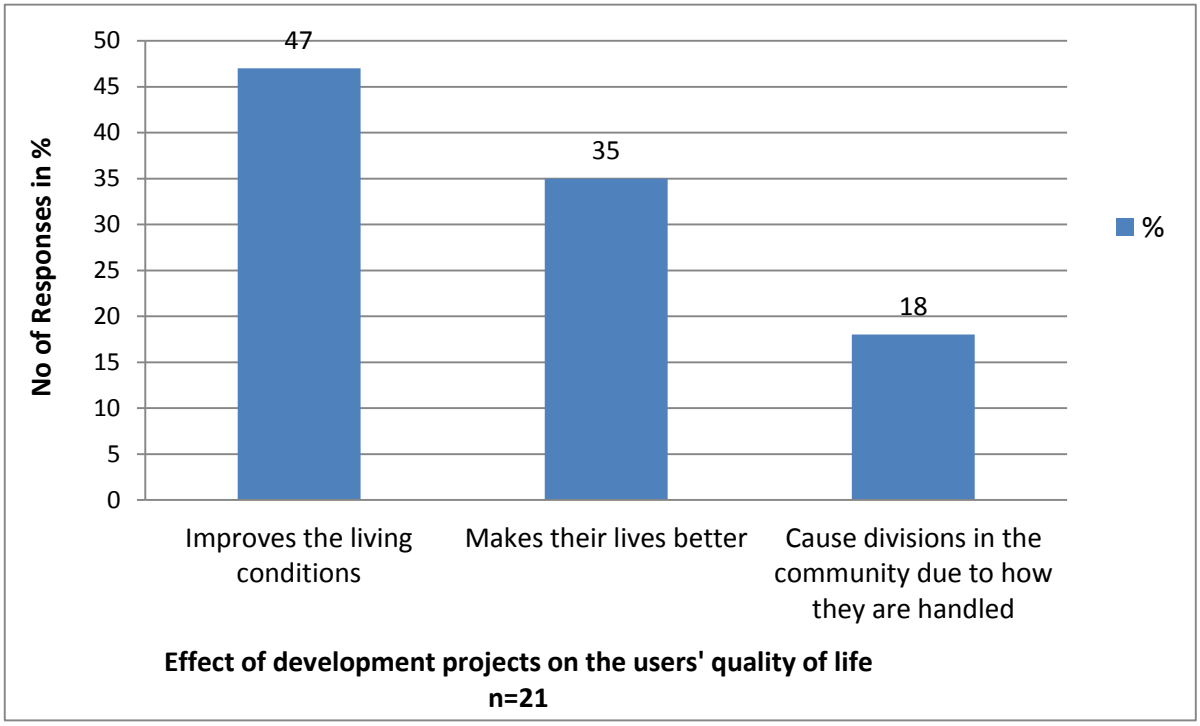


Figure 31: The effect of development projects on the quality of life of users in Dresden

4.8.5 Improving Project Delivery in Communities

Figure 32 indicates the views of participants in Cwebe on ways in which delivery impacts on community development projects. The graph indicates that 18% of the respondents said that it is important to involve community members in identifying their needs while 26% said the needs should be addressed as identified by the community. Furthermore 36% of the respondents highlighted the importance of doing site visits after project completion to ensure that the service was provided as reported by service providers. The other 20% indicated that maintenance of the resources should be provided to ensure sustainability.



Figure 32: Ways to improve delivery on community development projects according to participants in Cwebe

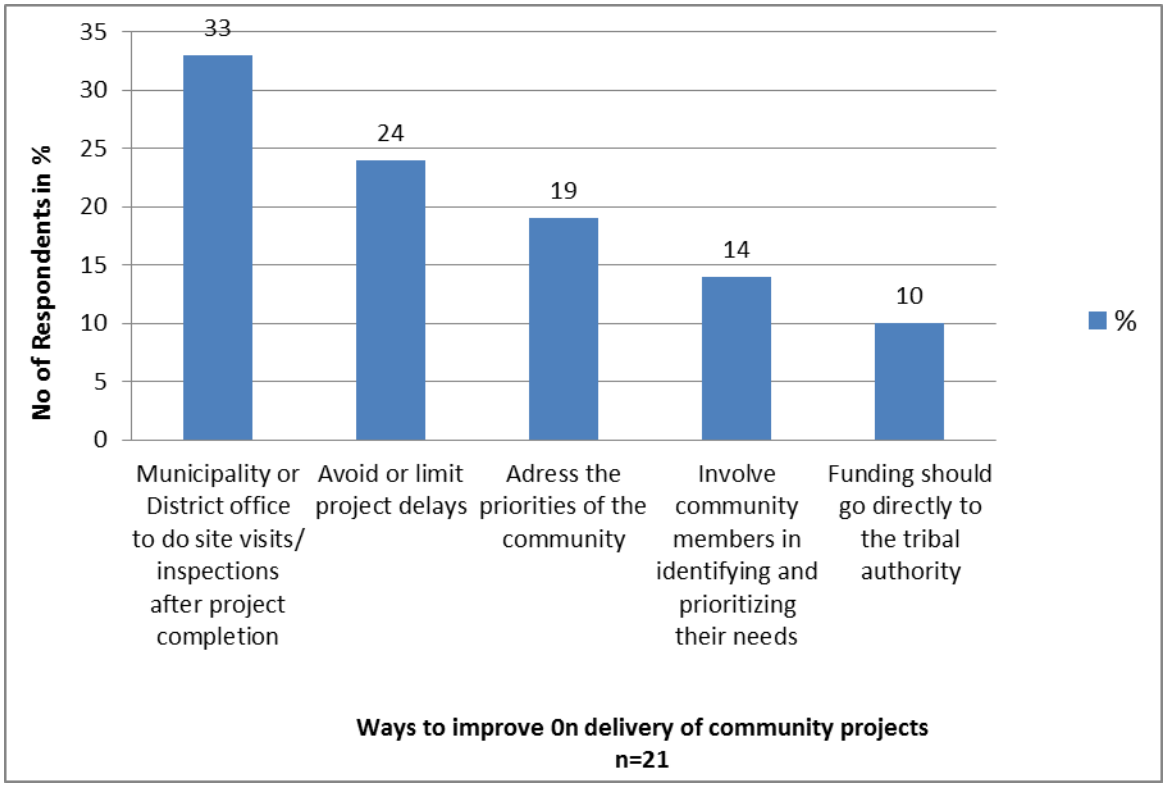


Figure 33: Ways to improve delivery on community development projects according to participants in Dresden

Figure 33 indicates the views of participants on ways in which delivery impacts on

community development projects in Dresden. The graph indicates that 33% of the respondents said that it is important to do site visits after project completion and 24% said project delays should be avoided or kept at a minimum. Furthermore 19% highlighted the importance of addressing the priorities of community members and 14% said community members should be involved in identifying and prioritizing development projects, while 10% said other user priorities should have been addressed. These are indicated in Figure 28.

All respondents agreed that funding should be made available for needs assessments and analysis in order to allow for appropriation of projects.

4.9 SUMMARY OF DATA PRESENTATION

4.9.1 Power Dynamics

Decisions on the projects, timing, and scope of projects are often taken without involving users, or even community leaders. The users often have to accept whatever that comes their way since it in one way or the other responds to a need that they have as communities.

Funders also come with their own expectations and basically work according to those without considering the priorities of the users. Funders are therefore in a position of power at the expense of users' pressing needs.

Municipal managements seem to also engage different stakeholders who are in a position to help without consulting or involving the users.

4.9.2 Project Funding

It is reflected in the data that communities have no control over the S&T project funding. The communities are also not involved in the management and investment of funds in order to address their needs. There are no reports provided to the communities in terms of sources of funding, what they are intended for and how they would be invested.

Value for money in terms of S&T investments is also not ensured as infrastructure is not maintained. Often there is a need for reworks as projects take too long and contractors are changed. There are no follow up site visits to ensure that quality work has been done and that projects are completed as reported. The main focus is on delivering on the requirements of the funders.

It is a common factor that politics influences access to S&T funding in communities. An example here is funding being linked to government elections.

4.9.3 User Involvement

The data presented reflects that users are often not involved in the planning of community development projects. Decisions on the projects, timing, and scope of projects are often taken without involving users, or even community leaders. While projects like water provision address a basic need in the communities, user involvement remains critical where social relevance is required. Priorities of communities are often ignored, knowingly and unknowingly as users are not involved in determining the needs that should be addressed in their communities.

4.9.4 Overall Relevance

While the S&T projects implemented in the two communities addressed a social need for access to clean water, relevance was compromised as the other pressing needs of the community members at the time were not considered. User involvement and priority assessment involving users were highlighted as critical in ensuring relevance of S&T produced by science councils. Conducting needs assessments and analysis has been cited as important aspects to allow for appropriation of S&T projects.

CHAPTER 5: ANALYSIS OF THE RESEARCH FINDINGS

This chapter presents an analysis of the main findings of the study. The chapter is organised such that the issues raised in relation to the research question are discussed sequentially. In order to contextualise the findings, the demographic profiles of respondents, as well as the aims and objectives of the water provision project are introduced first.

5.1 BACKGROUND

As described in detail in Chapter 3, this study used a combination of primary data collection through interviews and focus groups, as well as document analysis. It focused on investigating two water management projects implemented by the CSIR Built Environment operating unit in the Amathole and the Sekhukhune Municipal Districts using them as case sites. A number of different methods of data collection at community level were employed; these included participant observations and focus group discussions. In working with local communities, particularly in rural settings, it was also important to negotiate access through municipal, traditional and culturally relevant authority systems and this was taken into account in the research design.

The researcher also elicited data from specialists such as the CSIR R&D Managers and CSIR researchers in the CSIR. Researchers who worked on the projects or reviewed water provision projects (ASWSD I & II) were interviewed. R&D Managers in the CSIR Built Environment were also interviewed. Their profiles indicated that they were all S&T professionals as described in Chapter 3. All data were analysed together with the information gained from interviewing community members and stakeholders as well as reviewing relevant documents.

As discussed previously, Holbrook (2006) argued that the mandate of Science and Technology (S&T) ministers and ministries anywhere in the world is to harness S&T to support the social and economic development of the nation. While this may be the case in principle, this research has been carried out under the explicit

assumption that S&T performers function within the specific context of a national social, cultural, political, financial and economic system, frequently carrying with them the legacies of colonial, post-colonial and other forms of governance. According to the CSIR Fellows (2008), virtually all scientifically advanced countries have some portion of their SET capacity in partly government-funded, dedicated research institutions, despite having followed different development paths to achieve this. The study looked at the case of the CSIR as a PRO, with particular focus on the Built Environment Operating Unit water provision project. An overview of the project aims and objectives is provided next.

The main objective of the ASWSD project was to provide reliable safe drinking water through the application of science and technology. According to the internal project reports, the project under investigation had the following objectives:

> The Accelerating Sustainable Water Service Delivery (ASWSD1) aims to demonstrate how to expedite the provision of reliable safe drinking water (potable water) to underserviced, or unserved, communities living in remote rural areas through the application of science and technology.

The initiative was conceptualised by a national task team of various departments and role players and is funded by the national Department of Science and Technology (DST). The project engaged two science councils in implementation, namely: The Council for Scientific and Industrial Research (CSIR) and the Human Sciences Research Council (HSRC). It was designed as a pilot, where the intention was to test for sustainability and to develop a replicable implementation process for delivery of an intermediate level of water services in remote rural areas. There was an explicit intention to view these projects as a supplement to, rather than as a replacement of municipal water service delivery systems.

Given the above background the next sections focus on the analysis of the research findings.

5.2 EFFECTIVENESS OF PUBLIC RESEARCH ORGANISATIONS

The UNDP (2004) as well as Schaltegger and Wagner (2008) agree that the biggest challenge facing countries in the developing world include poverty, inequality, poor health services, lack of affordable housing, challenges to environmental sustainability, energy poverty, lack of responsive urban management, and a range of other issues that affect quality of life. In the view of the authors what is needed is a conscious and determined reorientation of science, technology and innovation to tackle these societal problems. Innovation including its S&T components, where these are relevant, ought to be directed at developmental challenges.

The CSIR mandate explicitly requires that the organisation contributes to the 'quality of life of the people of South Africa'. Given the South African context, there is a particular need to foreground the needs of poor and vulnerable communities. For this reason the CSIR has over the years launched a number of initiatives specifically focused on improving the quality of life of the poor through projects in targeted communities. These include the water provision projects based on S&T produced by the CSIR Built Environment operating unit.

This study suggests that while efforts and investments are made to deliver on the above mentioned mandate they are not optimised. This is supported by the response of users and other stakeholders in both communities that the water projects addressed their need for access to clean water but did not adequately address user priorities were however not considered in the project decision making processes. According to Geels (2004) social needs should pre-empt the direction in which technology is developed. This, he argues is critical to allow use and benefit of the S&T. The responses in this study showed that the projects were technology based and were pushed to society without inputs from the users. They therefor suggest the insight that while the projects addressed a social need of clean water in the communities, the projects did not address the users' pressing needs.

Welz (2003) makes a case that innovation occurs when unprecedented solutions

to either known or new problems are devised and then put to work. Hoffert (2006) argues that S&T therefore does not happen in a vacuum but amongst people and is executed by people. It is therefore very important to take the context into account in order to ensure social relevance, impact as well as the effectiveness of S&T. This was highlighted in the case of the water provision projects both in Cwebe and Dresden. Users of technology were not involved in the project decision making processes. The study suggests that the involvement of users would have contributed to a better understanding of the context within which the projects were executed and eventually the effectives thereof.

Coccia (2004) recalls the work of Arrow (1962), who argued that the social efficiency requires the diffusion of the results of research to society and, once distributed, the new knowledge becomes a public good. Coccia (2004) further argues that the evaluation of end-use relevance demands a shift in organisational mind set and performance indicators away from readily quantifiable outputs towards a consideration of more qualitative end-user outcomes that are less amenable to measurement, requiring both a greater tolerance of ambiguity and a willingness to learn from the evaluation process. There is a suggested weakness of not involving users and continuously getting feedback from them on the work delivered. The study gives insight that had users been kept actively involved in the evaluation of ASWSD I, the chances of improving on ASWSD II would have been increased. This would have likely increased the success rates of the ASWSD II.

The OECD (2002) makes a case that the measurement of relevance and effectiveness of S&T for social purpose on an on-going basis, as circumstances tend to change over time as technologies are introduced to societies and are adapted by them. The involvement and active participation of users is likely to assist in providing accurate and updated feedback on the possible changes. While the researchers reported Cwebe as a successful water provision case, the users and stakeholders confirmed that none of the solutions that were provided for their community based on the CSIR S&T were functional at the time this study was conducted. Therefore, this study suggests a disjuncture between technology and social circumstances. It gives insight that the involvement of users is critical in

order to ensure social relevance and effectiveness of technologies.

S&T that involve beneficiaries in design and diffusion processes are better placed to ensure that user needs are addressed and positive and potentially significant impacts on empowerment are produced. CSIR Fellows (2008) argue that to justify their privileged position as recipients of public funding not tied to specific projects, science councils and similar bodies need to ensure that they focus on fulfilling the role that they are best suited for: *longer term*, innovative and integrative research. Their project selection and evaluation systems must reflect this objective. The data generated in this research report suggests that projects did not meet the long term goals of providing access to clean water on a *sustainable* basis and provided only fleeting, short term relief. Lack of sustainability of project infrastructure could result in access to clean water, returning as a social challenge even after project implementation.

According to (Arora et al. 2001as cited by von Nell 2011), technology can take the form of intellectual property or intangibles, such as designs. Furthermore, it can be embodied in products or technical services. Therefore, technological knowledge may be considered as an “imprecise term for useful knowledge rooted in engineering and scientific disciplines”. Technological knowledge is usually developed for a specific context and a specific use, and it partly has a tacit nature. Thus, transferring it to a different context or using it in a different way can involve major problems, leading to a lower efficiency and to relatively high transaction costs in technology.

The participating researchers indicated that water filters were imported and distributed. The users in Cwebe, however, mentioned that at the time of the study, they no longer had the water filters as the clay ports that were part of the technology were broken and could not be used. This suggests non-sustainability of the water purification solution that was diffused in this community. While the technology could have been effective and practical in a different setting; this did not seem to be the case in Cwebe. The relevance of the solution provided, its usefulness, effectiveness, as well as its sustainability are therefore questionable.

The power dynamics in the water provision projects by the CSIR Built Environment project in Cwebe and Dresden will now be looked into.

5.3 POWER DYNAMICS

The power dynamics in this study were explored by looking at two main aspects: stakeholder or actor engagements with each other, as well as the project decision making process.

5.3.1 Stakeholder Engagements

Arora et al. (2001as cited by von Nell 2011) state that the development of S&T in the era of pre-industrial revolution was seen as the ‘unified science’. This referred to a balanced integration of philosophy, ethics, science, technology, sociology, economics and anthropology that could lead the world towards sustainable development. Based on this view, science councils have the responsibility to coordinate and collaborate with relevant stakeholders in an attempt to contribute to sustainable development. The study suggests that the users and stakeholders within communities are critical and should be involved from the beginning of development projects in order to ensure social relevance of the S&T outputs by science councils. There is a suggested oversight of this important dimension of effectiveness by science councils. All participants agreed that users and stakeholders were not involved from the inception of the respective projects.

According to the BEPA (2011), S&T for societal purposes are technologies that are social in both their ends and their means. Specifically, these are new/ and or improved ideas (products, services and models) that simultaneously meet social needs (more effectively than alternatives) and create new social relationships or collaborations. The study provides the insight that while the water provision projects addressed the need for access to clean water by the communities, its effectiveness was compromised. Users still faced the challenge of not having clean water even after the project was implemented. Frequent break down of the technology and lack of maintenance showed that it was not adequately managed and did not provide long term solutions that addressed the social need for water.

BEPA (2011) further argues that S&T for societal purposes are technologies that are not only good for society but also enhance society's capacity to act. This happens through *interactions* between individuals undertaken to reach certain outcomes, it is participative and involves a number of actors and stakeholders who have a vested interest in solving a social problem, and it also empowers the beneficiaries. There is a suggested weakness in not capacitating users to act in relation to the projects. The respondents in Cwebe indicated that they had reported the problems with the water station but did not receive any assistance. All respondents in Dresden indicated that while the community members took the initiative to start and self-fund a water distribution project, the Municipal Management stopped the community initiative and gave the project to the CSIR. This gives insight to the fact that the users and stakeholders in both communities were disempowered instead of being capacitated to act in shaping and contributing to the improvement of their living conditions. A case could be made that the CSIR had a chance to improve the social relevance of the projects by ensuring that the processes were participatory allowing users to also get involved.

ACDP (2013) claims that S&T should not be determined mechanistically; it needs to be nurtured so that it may emerge organically from a fertile environment. ST is related to its context: what is new in a particular context and has an impact is innovative, even if it has been done elsewhere. For instance, it must be nurtured at various levels, and in a way that is not only sensitive to its context, but that turns its context into an advantage (KAD Book 2008). While users are better positioned to accurately give inputs on the context issues, they were not involved in the pre-implementation discussions. This could potentially limit the effectiveness of projects, as users could feel disempowered. All respondents agreed that there was no involvement of users in the early stages of the projects.

Ginzberg (1981) conducted a longitudinal study of user expectations as predictors of project success or failure. The findings of this study suggested that project implementation failure is more likely when there are unrealistic expectations about the project. Users who have expectations that are more realistic are more likely to be satisfied with the outcomes. The CSIR could have managed the user

expectations better through interactions with the users and stakeholders from project inception.

Project decision making will be discussed next. This will be done by considering the specific stakeholders that were involved in decision-making, the timing of their involvement, as well as the respective levels of involvement.

5.3.2 Project Decision Making

Golnam and Ebrahim (2007) make a case that similar to other business models, S&T systems are characterized by complex structure and dynamic behaviour. It's often difficult to predict or trace the consequences of certain decisions due to the existence of delays; non-linearity and causal feedback inherent to such systems, in other words, the effect of making a decision on one part of the S&T function can manifest itself in another part of the business system at an unexpected time. Aligning and engaging people to strategy require a holistic, coordinated effort to ensure a number of key elements or building blocks are in place. The study suggests that science councils need to make effective decisions including on how they invest their funds, who they engage or collaborate with, the timing of their work, and most importantly, their priorities in terms of what they need to address.

S&T needs to be understood as fundamentally involving high levels of interaction between ranges of people; S&T is not produced in isolation. At the center of these interactions are the users whose lives will be directly affected by what gets produced and diffused into their communities. The study suggests that the CSIR had an opportunity to ensure that the projects contributed to job creation by employing relevantly qualified and skilled members of the communities of Cwebe and Dresden. The study however shows that on the contrary, contractors were allowed to come with their own workforce even for jobs that could have been filled by community members. Job creation as a social need was therefore compromised, negatively affecting the social relevance of the projects.

The OECD (2010) in its innovation strategy points to five priorities and associated policy principles for innovation, which include applying innovation to address

global and *social* challenges (Lorentzen 2010). According to Robbins (1998) while organisational development strategies are designed to increase productivity and quality, problem solving is a critical aspect of the process. The same goes for S&T, challenging organisations to strive towards impactful S&T in their production (Crozier and Friedberg 1993). They argue that social S&T, understood as innovations of social purpose, are an elementary part of sociology, and therefore in contrast to technical S&T can not only be analysed, but also engendered and (co-)shaped; they are oriented toward social purpose and require reflection on the social relationship structure. The study gives insight that there was an opportunity to make a clear decision to include users in the project decision processed from inception, however according to the study this was not done.

UNDP (2004) in the specific case of water management encourages politicians, decision makers and other stakeholders to facilitate the required changes in water governance with solutions that respond to the priority needs of water users. The study suggests that while the S&T projects at the two case sites addressed a social need by providing access to clean water, social relevance was compromised as the pressing needs of the users were not addressed. This is made evident by the fact that all respondents at both case sites agreed that there was no involvement of users and stakeholders in the communities in project decision making processes.

O'Malley (2004) makes a case that people should be involved in development programmes by being made part of the decision-making on where infrastructure is located, by being employed in its construction and by being empowered to manage and administer these large-scale programmes. An interesting observation was made that at both case sites, task teams were only established and engaged at project implementation stage. A question is also raised on the purpose and level of involvement at that stage; which was to facilitate interactions with the communities at project implementation phase. This suggests that users were not empowered to influence and co-shape the technologies that were diffused into their communities. Users were also not allowed the opportunity to give feedback

which could help with the planning and improvements for future projects.

It is evident that the project decision making power dynamics between the CSIR and other stakeholders in the project limited the chances of the projects being socially relevant. There is a suggested insight that the CSIR could have involved users in co-shaping the S&T hence ensuring usefulness of the projects as well as increasing the level of project ownership by community users and stakeholders.

5.3.3 Implications of Decision Making on the Social Relevance of the Project

In his innovation policy analysis, Netshiluvhi (2012) makes a case that stakeholders and a large body of literature reveal that social innovation is an area poorly understood worldwide. He classifies it as an emerging field that is generally poorly studied. He argues that social innovation cannot be easily measured by incompatible conventional metrics and is therefore neglected. The limited body of knowledge on social relevance of S&T informed the study as the emphasis in this regard is often placed on issues of impact (see Metcalfe (2007); OECD (2002); and Kuittinen et al (2007)). Based on this, there is no clear framework against which S&T produced by PROs can be assessed for social relevance.

With the significant limitations in terms of resources PROs need to ensure that the S&T produced is both socially and economically relevant in order to contribute to the improvement of quality of life for the general population. This requires coherence between SET and social sciences. There is a need for science and technological adaptation that is aligned with existing socioeconomic and sustainability challenges (Abrahams & Pogue 2012). The study suggests that the main focus of performance evaluation in the CSIR is on impact. There is however a suggested weakness on impact because while the CSIR strives to produce impactful S&T, their overall objective was compromised in the planning and implementation of projects.

The study suggests that organisational business strategies need to be aligned with the mandate of the CSIR. The CSIR Fellows (2008) suggest that instead of focusing on the areas of comparative advantage, science councils often try to be

universities, on the one hand, or private-sector consultancies on the other. They argue that at best this leads to sub-optimal S&T outcomes; damaging both the science councils and the entire innovation system. They highlight “short-termism” as short fall for science councils. They argue that science councils perceive their income to be under threat, and are only certain of their budget allocation for a single financial year, which means that they do not commit to the long-term, large projects where their advantage lies and this is viewed as mostly self-inflicted constraint. While the CSIR aim to deliver work that has strong impact, the case sites in this study reveal that the sustainability of the work delivered is at times not there. The detailed findings presented in Chapter 4 present strong contention of this study in the case of a water management project.

There is a suggested limitation to effectiveness and relevance in that decisions on the projects, timing, and scope are often taken without involving users, or even community leaders. The users often have to accept whatever comes their way since it in one way or the other responds to a need that they have as communities. It was established that municipal managements seemed to also engage different stakeholders who are in a position to help without consulting or involving the users. Instead of involving users early enough in the projects, engagements happened between the CSIR and other stakeholders such as the local government but excluded users.

In line with the “lead user” concept by Von Hippel (1986) end-users in Dresden first felt the need for water provision and made an attempt to create it for themselves. The CSIR was brought in by the municipality to handle the project and provide the most appropriate solution for the users. Smits (2002) made an assumption that science, technology is the work of man, and its shape and form is given meaning by society. This was however not the case in the water provision projects at both case sites as users just had to accept what was being offered and implemented in their communities; thus limiting the social relevance of the projects.

CSIR Fellows (2007) make a claim that there is often a three-way clash of cultures between 'academic' environments, government entities, and commercial

organizations. They argue that academic institutions place their highest priority on curiosity and truth, while government agencies simply want implement-able solutions that work. Companies are strongly focused on returns to shareholders, which emphasizes delivery to specification, timeliness and working within budget. Interface organizations, such as science councils, have to be able to connect to all these cultures in their S&T production chain. This requires a particular culture of their own, characterized by pragmatism, project-orientation and trans-disciplinarity.

As cited by Grimm, Fox, Baines, and Albertson (2013), Franz, Hochgerner, and Howaldt (2012) argue that it is the intentionality of social innovation that distinguishes it from mere social change. They make a case that part of the difficulty in defining social innovation which includes S&T comes from both its potential to meet pressing social needs and its use of new social processes to deliver products and services. In other words, social innovation can refer to both the means and the ends of action. Thus, social innovation may refer to products and services that help to build more sustainable, cohesive and inclusive societies. The study suggests that while these collaborations are important, they should not happen if in the process users are left out as social relevance is likely to be compromised in such cases. The findings of this study indicate that users were left out of the loop.

The study suggests that local politics commonly influenced access to project funding in communities e.g. funding being linked to government elections. This compromises the quality, effectiveness, and most importantly relevance of projects in addressing the social needs of users. van de Ven (1993) in his review of John R. Commons' Institutional Theory sited that Commons viewed *society* as a complex social organisation rather than an organism or a mechanism driven by natural external forces or an automatically self-correcting system. Commons makes a case for social organisation as consisting of purposeful individuals whose actions are interdependent under conditions of scarcity.

There is a suggested insight that as a PRO with a specific mandate, the CSIR while trying to coordinate and collaborate with different stakeholders in the S&T

chain, implements projects according to agreements with funders at the expense of the users' pressing needs.

The focus now moves on to the issues of project funding and value for money.

5.4 PROJECT FUNDING

According to David and Metcalfe (2007) PROs engage in research and development as well as science and technology activities with substantial funding support from public and quasi-public (e.g. charitable and non-profit foundation) sources. OECD (2011) makes a claim that increasing demands for research that is both relevant and excellent have led PROs to aim for greater management flexibility and to seek diverse sources of funding in order to increase their autonomy. The CSIR Fellows (2008) argue that carving out a significant SET niche in the modern world generally requires large and sustained investment. They make a claim that S&T is, by definition, an uncertain business. While it can be demonstrated retrospectively that the occasional brilliant success more than pays for the hundreds of failures, it takes a certain scale of investment to successfully participate in such a high-stakes, high-risk game. Given this background and the success risk levels, it is not easy for science councils to source and secure funding for S&T development.

5.4.1 Competitive Funding

The OECD (2011) argues that globally, in the last decades, despite the predominant role of block grants and direct transfers, governments have put more emphasis on competitive program funding as a way to steer research and implement priorities, although block grants still represent the highest share of public funding for PROs. Due to the competitive approach for funding, organisations including science councils are strongly focused on returns to shareholders, which emphasizes delivery to specification, timeliness and keeping within budget. This unfortunately does not focus much effort on the social relevance of S&T as client expectations and impact seem to take centre stage.

There is a suggested weakness in that performance seems to be measured based on the project being completed on time, according to specifications, and within budget. This compromises the delivery on the actual mandate of a science council such as the CSIR; which is to contribute to the improvement of the quality of lives of the people of South Africa.

The study suggests that in order to remain competitive and get access to project funding, the CSIR built environment water provision project, focused on delivering the project as agreed with the client consequently compromising the usefulness and sustainability of the water infrastructure. This is based on the fact that according to the respondents in Cwebe, on the day the project was launched, the water filters were already blocked and had not been serviced therefore their usefulness was compromised. Besides it being short lived, the finding suggests concerns regarding technology appropriation and social relevance. Both S&T managers who participated in the study indicated that the main issue of concern was the impact that projects would have. There is however a question to be raised regarding monitoring, evaluation and maintenance as a way of maintaining usefulness, sustainability as well as value for money.

South Africa's science and technology profile is mixed. While the country has a relatively strong national system of innovation, the lack of human capital is a major drawback. The country suffers from poor-quality schooling, worryingly low levels of entrepreneurship, a chronic shortage of high skills and underinvestment in research and development (S&T) (NACI 2009; Marcelle 2010). As cited by the National Planning Commission, the OECD's *Review of South Africa's Innovation Policy* (2007), for example, reveals investments in S&T to be consistent with South Africa's status as a middle-income industrialising country, although the number of researchers (2.7 per 1 000 people) was far lower than that of peer countries (the OECD average was 8.0 per 1 000 people) and funding levels were also modest.

According to literature, the way projects are funded could have certain influence on the approach. The next section looks at project funding in relation to science and technology provision (OECD 2003, Howaldt and Schwarz 2010, as well as

Klerkx and Leeuwis 2008).

5.4.2 Funding and Science and Technology Provision

Science councils in South Africa are mandated to produce S&T that contributes to the improvement of the quality of life of the South African population through transfer and adoption of innovative science. This is seen in the mandates of the respective science councils as stipulated by government. Government allocates money in the form of parliamentary grants to enable the science councils fulfil their mandates. Most of the clients serviced by the science councils are government departments who often come with specific needs in terms of work that they require these councils to do for them. Science councils often have to respond to the funding models of clients in determining S&T projects that they carry out. This did not prove to be any different for the CSIR Built Environment operating unit. Emphasis is placed on delivering projects within scope, on budget, and on time.

The OECD (2003) asserts that as distinctions between fundamental and problem-oriented research have blurred, and demands to make public research more responsive to the needs of business and civil society have mounted, there is a greater need for increased and more efficient linkages between science and technology. Such linkages serve to both facilitate industry's uptake and commercialisation of public-sector research outputs as well as ensure that research performed in the public sector is attuned to social and economic problems. As cited by Howaldt and Schwarz (2010) "Creativity and innovation in general and social innovation in particular are essential factors for fostering sustainable growth, securing jobs and increasing competitive abilities, especially in the midst of the economic and financial markets crisis". They argue that the relationship between technological and social innovation is changing with the transition from an industrial society to a knowledge and service economy. There is a suggested opportunity for the CSIR as a science council to bridge the gap between technology and the users through active user involvement in projects in response to social needs.

Klerkx and Leeuwis (2008) make a claim that separating funding from provisioning of S&T makes service provision demand driven, because in a market setting services are contracted and several providers compete for contracts, and this enhances provider performance and orientation towards clients' wishes. They further argued that the situation is strikingly different in many developing countries, where end-user steering of S&T planning is insufficiently institutionalized. The study suggests a weakness in demand driven service provision as it indicates that some funders also come with their own expectations and researchers work according to those without considering the priorities of the users. According to this finding, funders are therefore in a position of power at the expense of users' pressing needs, resulting in service being pushed to users without prior assessment of suitability, usefulness and effectiveness.

Although government undertakes various initiatives to support and accelerate the rate of S&T by setting up institutions and programs (including grants), at large, there are still gaps that need urgent attention. Research institutions receive minimal grants from government which they have to use for S&T that contributes to national development. Early stage development funds can come from sources such as industry and companies that wish to explore new science, universities and other research institutions or government grants. The study reflects that S&T projects are implemented according to the contractual agreements between the CSIR as a science council and the respective funders. The study suggests that the needs expressed by the users often cannot be attended to if they are not in line with what has already been agreed to in these contracts. This therefore raises a question on the role played by users in order to ensure that S&T projects address their needs and priorities.

There was an element of low levels of sense of ownership of the project infrastructure by users which emanated from the "sudden" project implementation that did not initially include users and stakeholders. Findings on user involvement in producing science and technology will be discussed next.

5.5 USER INVOLVEMENT

Over the years and particularly since the 1990s, the system of innovation concept has become the most widely used as a framework for policy making and implementation. In the systems approach, patterns of innovative processes and outcomes arise from or are generated by a complex interplay between firms, financial institutions, industrial networks, public institutions, governments, universities, *consumers, communities*, and other organizations. In this approach the focus is on *interactions* across and between these agents (Edquist, 1997, Freeman 1982, Lundvall 1988, 2010 and Nelson 1993).

5.5.1 Stakeholder Involvement in Producing Science and Technology

Literature shows public research organisations play an important role in harnessing S&T to support social and economic development of the nation. In order for PROs to be effective in doing this, they need to be well managed and financed, have the relevant infrastructure, engage in beneficial collaborations and have the appropriate capabilities. More importantly, PROs need to follow the best suited approaches in producing science and technology and even research and development (Holbrook 2006, as well as Kahn and Hounwanou 2008). According to Cornwall (2002) Participatory Development (PD) seeks to engage local populations in development projects.

Although firms and industries are important actors in technologies, other groups such as the users, societal groups, public authorities, research institutes are also relevant (Crozier and Friedberg 1993; Brooks 1994; Geels 2004; Hobday 2005; Tacchi 2008). It is emphasized that although these groups have their own characteristics, they are also interdependent. The dynamics and relationships of these groups can affect how they respond to technology and innovation in their environments. Figueiredo (2006) makes a case for the importance of designing organisational and institutional arrangements in line with the need for technological change in the process of technological capacity building. This study is in line with these claims and confirms that social needs should pre-empt the direction in which

technology is developed. This is critical to allow use, benefit and sustainability of the technology unlike when it is based on S&T and is being pushed on society (Geels 2004).

Literature suggests that science and technology is the work of man, and its shape, and form is given meaning by society. It is also believed that S&T comes about when unprecedented solutions to either known or new problems are devised and then put to work (Smits 2002 and Weltz 2003). S&T therefore does not happen in a vacuum but amongst people and is executed by people. Participatory development is an approach that is recommended for development projects (Cornwall 2002, Mohan 2008, as well as Taylor and Francis 2000). The importance of the involvement of the people amongst which S&T happens has been highlighted by the responses of users in this study.

The study raises a question on the effectiveness of technology when it is not given meaning by society. Innovations need to be co-created by the experts involving users in the conceptualisation processes. Implementing technology that was not developed taking into account preferences and practicality factors for users, means gets designed and dispensed to the users without considering their views, as recommended by the participatory development approach.

Chambers (2004) makes a case for enabling the poor and marginalised to analyse their realities, to identify and express their priorities, and to gain for themselves and their families what they need and deserve. The study therefore suggests that S&T produced by science councils could be better informed through interactions with users and stakeholders to ensure social relevance of their work in efforts to address the needs and priorities of users. These interactions could potentially contribute to the strengthening of the social relevance of S&T and technological capabilities. Watkins and Tacchi (2008) note that participatory content creation is an important tool for poverty reduction strategies and creating a digitally inclusive knowledge society. The social relevance of S&T produced by science councils could potentially be improved by active user involvement and participation in projects.

Chaminade et al. (2009) argue that the growing body of literature dealing with S&T in developing countries recognises context, specificity is acknowledged in principle. They argue that a considerable part of this literature fails to acknowledge the peculiarities of developing countries, particularly the specific needs for poverty-reducing and socially inclusive types of S&T. They further argue that the role of government as agents or resource allocation is overestimated. Even though governments' limited implementing capacity is often recognised, they are often implicitly assumed as entities that are only, or mainly driven by their wish to maximise social welfare.

The CSIR has a mandate to produce R&D that contributes to the improvement of the quality of life of the South African population. There is a suggested challenge that science councils seem to have moved away from this mandate with projects that are delivered providing sustainable, cohesive development science and technology. As captured in the internal CSIR reports, the main aim of the ASWSD project was to provide *reliable* safe drinking water through the application of S&T. The study raises a question around the reliability of the project as the technology was reported to have been non functional for months at the time of the study. Thus, the CSIR's "mandate" need not be seen as a directive to run and control the project predominantly by itself, but rather, the CSIR could have improved on the sustainability of the infrastructure delivered in order for it to be useful and add value in the lives of users.

David and Metcalfe (2007) argue that research is the most critical component of any effective Planning, Implementation, Monitoring and Evaluation of the impact of programmes designed for the benefit of ordinary people. They make a claim that virtually all scientifically advanced countries have some portion of their SET capacity in partly government-funded, dedicated research institutions, despite having followed different development paths to get to that point. This is empirical evidence of a sustained role for science councils, even after their initial function as a development intervention has been achieved.

5.5.2 User Involvement

The study suggests that the social relevance of (S&T) produced by science councils in South Africa based on the case of the CSIR Built Environment unit, water management project is weak. This is as a result of the lack of user involvement in the project decision making processes. All participants in Cwebe agreed that the water project was decided upon in response to the cholera outbreak in the area. Providing access to clean water to the community would have helped to address the health issues in Cwebe as a result of unsafe drinking water. The CSIR would likely increase the ownership and acceptance of the technologies by empowering the users to influence and shape the technology that is best suited for their context. This could not have been achieved without involving users in the project decision making process. On the contrary, all participants in Cwebe agreed that they knew nothing about the project decision making processes that were followed.

It is evident that at this stage the engagement with the users was directly with the district management representatives. Although the CSIR had to come up with a best suited technology for Dresden, within the ASWSD framework, the CSIR was not included in the discussions. The fact that there was a demand for immediate delivery from community members to the district office could have had a bearing on the response, given the fact that elections were scheduled for the same week. The study suggests that the involvement of users would have likely been more constructive and realistic had it been arranged proactively by the CSIR as the project manager. This would also have allowed them the opportunity to manage user-project expectations.

According to Cornwall (2002) Participatory Development (PD) seeks to engage local populations in development projects. Cornwall makes a case that PD has taken a variety of forms since it emerged in the 1970s, when it was introduced as an important part of the "basic needs approach" to development. Most manifestations of PD seek “to give the poor a part in initiatives designed for their benefit” in the hopes that development projects will be more sustainable and successful if local populations are engaged in the development process. Mohan

(2008) argues that PD has become an increasingly accepted method of development practice and is employed by a variety of organizations using the basic needs approach. PD seeks to engage local populations in development projects, which is an important aspect of project management.

Findings presented in Chapter 4 is - reflective of the fact that in both cases users were not involved in the process of shaping the S&T as well as in making decisions that influenced the final S&T output. While all participants in Cwebe agreed that they did not know anything about the project decision making process; the majority of the respondents in Dresden reported that the Water committee was only involved at the project implementation phase after the project, its scope and timing had been decided upon. Fewer respondents indicated that project decisions were taken by the Municipal Management.

The study findings show conclusively that users and community stakeholders are commonly often only included into projects during implementation. By then it is too late or even impossible to influence the decisions that have been made about these projects; as not only would decisions have been taken but often investments in terms of the design and approach would have been made. This increases the risk of re-works and results in some of the project funds going to waste, as stated in the case of Dresden. While projects like water provision address a basic need in the communities, user involvement remains critical in order to achieve social relevance. The study suggests that priorities of communities are often ignored, knowingly and unknowingly as users are not involved in determining and prioritizing the needs that should be addressed in their communities. Users are in this way not empowered in shaping their living conditions.

According to Mohan (2007) advocates of Participatory Development (PD) emphasize a difference between participation as “an end in itself”, and participatory development as a “process of empowerment” for marginalized populations. Osmani (2007) argues that this has also been described as the contrast between valuing participation for intrinsic rather than purely instrumental reasons. Sen (2002) suggested that in the former manifestation, participants may be asked to give opinions without any assurance that these opinions will have an

effect or may be informed of decisions after they have been made. In the latter form, proponents assert that PD tries to “foster and enhance people’s capability to have a role in their society’s development”. The involvement of users in project decision making processes is very important in order to ensure relevance of the S&T produced by science councils. The study suggests that by doing this, the CSIR is likely to close the gap between the technology and its users. The overall relevance of producing science and technology will now be looked into.

5.6 OVERALL RELEVANCE

Extensive amounts of work have been done by multiple sources towards assessing the outputs of Public Research Organisations (PROs). Although the literature covers a wide variety of theories and thoughts around this issue with great emphasis on impact, this study focused on the social *relevance* of science and technology (S&T) produced by PROs.

The importance of addressing what users and stakeholders really need and value is illustrated by the response of users to the issue of how relevance of S&T work can be ensured through projects. There is a suggested need for needs analysis through user involvement. The CSIR had the opportunity to understand the needs of the users and be better positioned to influence future development plans based on feedback from users. This highlights the point that the CSIR could be better positioned to have a broader understanding of social needs in communities they work with through early user involvement. This was confirmed by the response received from Dresden on the same issue where 33% of the respondents said it is important to check with the users what their most urgent needs were.

The findings also indicate that the majority of respondents in Dresden further stated that it is important to dialogue directly with users with regards to their most *pressing needs*. The study is not in line with the argument that relevance on the other hand is about addressing issues that are deemed critical and also prioritized by members of the society in order to satisfy their human needs. It should therefore be a requirement that the S&T addresses issues that according to the users empower them to relate with others and be in a position to influence and/or

access resources that satisfy their human needs. This highlights the importance of user involvement in needs analysis and determining priorities that must inform development projects that should be implemented to improve the quality of life of people in different communities.

Cornwall (2002) indicates that most manifestations of PD seek “to give the poor a part in initiatives designed for their benefit” in the hopes that development projects will be more sustainable and successful if local populations are engaged in the development process.

5.7 SUMMARY OF THE RESULTS

There is a common lack of user involvement in project decision making processes and a sustained system of providing feedback to communities on the projects delivered. Users were commonly only engaged in projects during the implementation phase leaving them no option but to accept the projects that come their way. Users and stakeholders were not empowered to shape and contribute to the improvement of their living conditions. This limited the chances for continuous S&T projects improvement in order to increase project success rate. Changing of contractors and prolonged project delivery periods also compromised value for money in project investments. Politics also evidently influenced access to S&T funding.

Users reported that their priorities were not addressed even when they had expressed them. Project decision making power dynamics between the CSIR and other stakeholders limited the social relevance of the two projects. There is a suggested disjuncture between the technology and the social circumstances. User involvement in co-shaping the S&T would have assisted in ensuring usefulness of the projects goals increasing the levels of project ownership by users. User expectations could have also been managed better through interactions with users from project inception. The study suggests that the involvement of users would have contributed to a better understanding of the context of the projects and eventually the effectives thereof. Conducting needs assessments and analysis has

been reported as important aspects to allow appropriation of S&T projects.

Based on these findings, a case could be made that the CSIR had a chance to improve the social relevance of the projects by ensuring that the processes were participative allowing users to also get involved.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

This research is a preliminary study into exploring the social relevance of science and technology produced by Science Councils. The study examines the social relevance of water management projects designed, developed and implemented by a formal science and technology organisation. This chapter presents the main conclusions relating to the research, providing recommendations for public research organisations and funders of innovation. The chapter finally puts forward recommendations for further research.

6.1 Key Conclusions of the Study

The study proves that a lack of integration negatively impacts project sustainability only providing fleeting and short term relief. Projects do not meet their long term goals due to lack of sustainability. Limitations in the sustainability of the technology can be attributed to low levels of environmental awareness with the effectiveness of S&T implementation becoming incidental.

Recent research in developing countries, such as findings of periodic Innovation Surveys, confirms that a majority of developing country firms do not regard interaction, particularly with public sector bodies and universities, as being important for their innovation processes. In view of this research, this may be explained in part by a failure to have a segmented approach to designing and delivering the services of these public bodies.

In the work that underlies this research, there is much more of a political and even ideological content to ensuring that issues of power, control and ownership of resources, and governance in the innovation process are on the agenda for interrogation. The following are the key conclusions that have been drawn in relation to Power Dynamics, Project Funding, User Involvement, as well as Overall Relevance in the context of the study.

6.1.1 Power Dynamics

The study shows that decisions on the projects' timing and scope of projects are often taken without involving users, or even community leaders which is contrary to the essence of PRA as explained above. It is evident from the study that users and stakeholders in the communities are not afforded the opportunity to express their reality in terms of their pressing needs. The social relevance of S&T was compromised with the high levels of dominance over community members by science councils.

The CSIR assumed responsibility for technical research and development, as well as the project management in the ASWSD project. As part of project management, active participation of communities could have been facilitated in the development of beneficial relationships between the science council and the communities. It is evident that science councils do not engage users in project decision-making processes. This results in lack of continuous, active participation of users in S&T projects.

Designing organisational and institutional arrangements in line with the need for technological change in the process of technological capacity building is crucial. The social needs should therefore pre-empt the direction in which technology needs to be developed. This is critical to allow use, benefit and sustainability of the technology unlike when it is based on S&T and is being pushed on society.

Sharing the methods which local people could use for their own appraisal, analysis, planning, action, monitoring and evaluation is likely to improve opportunities for successful transfer of technology. User involvement would have allowed for the opportunities to enable local people to have better opportunities for producing socially relevant S&T without imposing it on the communities.

6.1.2 Project Funding

There is conclusive evidence that science councils lack internal consideration of the environment in the development of science and technology in order to ensure that the applied technology is appropriate for each project. The low levels of environmental awareness can be attributed to lack of involvement of users in informing the development of contextually relevant and best suited technology.

OECD (2011) confirms that increasing demands for research that is both relevant and excellent have led PROs to aim for greater management flexibility and to search for diversification of funding sources in order to increase their autonomy. A case is made that it is unlikely that there will be “radical” innovations in the core motivations and interests of PROs, but rather incremental adaptive processes. Despite this confirmation, there continues to be reduced success in the diffusion and implementation of technology.

The main focus for science councils is on delivering projects as agreed, on time, within budget irrespective of where it leaves user priorities unattended to. While this approach allows them to earn their income, the social relevance of the S&T produced is left questionable.

6.1.3 User Involvement

Effective interactions with users and stakeholders, which could potentially contribute to the strengthening of the social relevance of S&T and its technological capabilities is lacking in South African science councils. Chambers (2004) makes a case for enabling the poor and marginalised to analyse their realities, to identify and express their priorities, and to gain for themselves and their families what they need and deserve. It is evident from the study that the approach to S&T produced by science councils could be better informed. Science councils however, are seen to be ineffective in the way they interact with users and stakeholders, as well as in terms of user priorities being compromised in the process.

Participatory approaches to development are inherently superior to those that are more technocratic and authoritarian. The poor and marginalised should through these kinds of processes, be provided opportunities to be empowered and to analyse their realities as well as to identify and express their priorities. Users should be actively involved and allowed to participate in the decision-making processes from the inception of projects that directly affect their well-being. This is a critical consideration in terms of the social relevance of S&T.

While Mohan emphasises the importance of mapping and ranking of preferences by communities which was not done in this study, it is evident that lack of involvement of communities in setting out priorities negatively affects the social relevance of projects. As cited by Mohan (2001), Village AiD (1996: 7) suggests that ideally village communities should set the agenda for projects and outside agencies need to become responsive to those agendas. Contrary to this, the study reveals that users often have to accept the outcomes of a project that were implemented since it in one way or the other responds to a need that they have as communities.

6.1.4 Overall Relevance

Science councils are strongly focused on giving returns to stakeholders, which emphasizes delivery to specification, timeliness and working within a specified budget. As interface organizations, science councils have to be able to connect to all the cultures within the S&T chain. This requires the application of a particular culture, characterized by pragmatism, project-orientation and trans-disciplinarity.

The low success rate of the implemented technology in the two case sites confirms that approaches to S&T that are aligned with perspectives that regard participatory approaches to development are inherently superior to those that are more technocratic and authoritarian. It is evident that science councils do not use the PD approach which seeks out the diversity which allows the differences between people and between communities to be realised. Reduced success in the implementation and technology diffusion of ASWSD II can be attributed to a lack of

monitoring and evaluation in order to ensure successful adaptation and improvements based on the learnings from ASWSD I. The lack of active user involvement was carried through from phase I in Amathole District Municipality to phase II in Sekhukhune District Municipality.

Users should not have to be forced to accept project outcomes that ignore their own specific needs even though in one way or the other they respond to certain needs that they have as communities. Evident from the study is the lack of involvement of communities in setting out their priorities, which negatively affects the social relevance of projects. Science councils should be responsive to agendas set by communities based on their priorities.

6.2 Recommendations

The research outcomes have implications for both Public Research Organisations and funders of innovation. This section discusses the recommendations based on the research outcomes.

6.2.1 Public Research Organisations

Leadership in science councils should investigate a number of issues relating to user involvement in producing science and technology. According to the relevant literature, S&T for social purpose is engendered and (co-)shaped in conjunction with users. It is recommended that leadership in science councils consider and investigate the various opportunities for improving social relevance of S&T and adapt them for their particular organisations. It is recommended that participatory development and innovation for social purpose be considered for application (Cornwall 2002; Mohan 2008; Taylor and Francis 2000).

Recommended approaches while not limited to, include the following:

- Consideration of "user-driven innovation". Produce S&T that is not solely focused on technology and the economy but also addresses public demand as well as priorities of users. It would have to be relevant to the needs of the target groups in society (Hobday 2005; Mohan 2001; O'Malley 2004).

- Consider empowerment of the poor to participate in decisions that affect their lives. Use a participatory development approach to understand the realities that need to be addressed, empower the voiceless in shaping their lives, while remaining instrumental in proposing new alternatives (Chambers 1983; Mohan 2001; Chambers 1997).
- Considering collective and co-creation of innovation. Involving users in shaping science and technology that will be implemented to directly change their lives (Crozier and Friedberg 1993; Brooks 1994; Geels 2004; Hobday 2005; Tacchi 2008).
- Considering socio-economic contexts in shaping the capability of organisations, regions or countries, and interacting with users and stakeholders in order to understand the peculiarities of specific settings as it is the context of each setting that will shape its S&T capabilities (UNDP (2004); Chaminade et al. 2009; BEPA 2011).
- Considering collaborations and stakeholder engagements. Establish partnerships and collaborations that allow science councils to tackle 'societal challenges' through new forms of relations between social actors (Hobday 2005; BEPA 2011).

It was found that delivery on user expectations by science councils was an important factor to users and stakeholders. Science councils should involve users more in the determination and analysis of social issues that should be addressed. The study examined the relevance of a water management project designed, developed and implemented by a formal science and technology organisation in rural settings in the Eastern Cape and Limpopo, plagued by problems of poverty, unemployment and other forms of deprivation. Consideration of the users' priorities is recommended.

6.2.2 Funders of Science, Technology, Research and Development

It is recommended that funders and science councils should consider what users and stakeholders in specific societies view as social priorities, as the basis for project decision making. This will assist with ensuring social relevance of S&T

produced to address the pressing needs of the people in South Africa.

It is further recommended that where clients approach research organisations with specific requests, needs analysis should be more frequently included as part of research proposals presented to clients who are more often than not the funders of S&T. Issues that come out of the needs analysis could further inform future development projects ensuring the relevance of such projects.

It is recommended that a problem-solving approach to S&T should be adopted as an urgent priority rather continuing the current approach which is orientated more to the prestige and seduction of large scale science-based projects aimed at producing radical breakthroughs. South Africa needs to continue its efforts to build its stock of relevant STI capabilities but to guard against a supply-push-based approach to science and technology, in particular S&T policy needs to be much more focused on developing a problem-solving, developmentally aligned approach.

6.3 Suggestions for Further Research

From the literature review, it has been established that the social dimensions of S&T have not received a great deal of attention. It is recommended that there is a considerable amount of work to be done, both at a conceptual and empirical level to understand linkages between and among non-profit orientated organisations and with communities. It is recommended that the work on social and cultural systems and on segmentation be given much more attention and focus. Additionally, it may highlight the importance of closing the gaps between the suppliers of S&T support services, as well as their “users”.

It is suggested that research be undertaken to determine the extent to which the dynamics and relationships of actors in S&T, such as users, societal groups, public authorities, research institutes, can affect how they respond to S&T in their environments. It would be appropriate to investigate the extent of user involvement in S&T management and understand its influence on the relevance of the intended S&T outcomes.

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APPENDIX A :

DISCUSSION PROTOCOL FOR FOCUS GROUPS WITH COMMUNITIES WHERE WATER PROVISION PROJECTS WERE DELIVERED

The purpose of this research is to obtain perspectives regarding the social relevance of Science and technology (S&T) produced by science councils, as well as, to provide evidence regarding the selection and decision making processes used in science councils to identify S&T projects.

These questions are directed at community members and stakeholders where water provision projects were delivered based on S&T produced by the CSIR built environment unit.

AGENDA

1. Welcome and introductions
2. Purpose of the meeting
3. Process and rules
4. Group discussion
5. Attendance register
6. Conclusion and vote of thanks

a. **BIOGRAPHICAL INFORMATION**

Date: _____

Location: _____

Community: _____

Interviewee's Role: _____

b. **PROJECT BACKGROUND**

1. Has there been any community development project in your community in the past 3 years?
   - If yes, which project was this?
   - What was the project all about?
   - Any water provision project?

Note: The following questions should be answered based on the CSIR water provision project)

2. How did the project come about?
   - Who decided on the type of projects and its timing?
   - What was the scope of the project?
   - What aspect of water provision did the project focus on?

c. **POWER AND DECISION MAKING**

3. Who decides on the projects that should be delivered in your community?
   - How was the water provision project decided upon?
   - How was the scope of the project decided upon?
4. Which key stakeholders were involved in this project?
   - What were the roles of the different stakeholders?

5. Were users involved in the project decision making process?

d. **PROJECT FUNDING**

6. How was the project funded?
   - Who provided funding for the project?
   - How was the funding sourced/ secured?
7. Were there any conditions for the funding?
   - If so what were the conditions?
8. Was value for the money invested in the project ensured?
   - If yes, how was that done in this specific project?
9. Is there consideration of how the projects will support the quality of life of the users?
   - If yes, how was that done in this specific project?
   - How is work delivered to your community such as this water provision project aligned with your needs as a community?

e. **USER INVOLVEMENT**

10. Do you know about the CSIR?

- If so, what do they do?
- To what extent do you think the CSIR understands the expectations of the users of their S&T work?
- How important is it for the CSIR to deliver on these expectations?
- In your opinion, how relevant is the work produced by the CSIR Built Environment Unit to social needs?
- How do you determine relevance of such work?

11. Was there any involvement of the users in the project?

- If yes, at what stage of the project were they involved?
- How did the involvement come about?
- What was their role?

12. Do you think there is ever any contradiction between user expectations and the requirements of the research funders?

- If yes, are these adequately dealt with?

f. **RELEVANCE**

13. Do you feel as the community you have a say in the projects that get delivered to you?
    - How important is it to you for the community to be involved in this regard?
    - To what extent do you think these projects affect the quality of life of people in the community?
14. What do you think could be done to improve the delivery of projects to the community?
15. Is there any other information that you would like to highlight about the water provision project in your community?

Thank you for participating in this study.

APPENDIX B:

INTERVIEW PROTOCOL FOR R&D MANAGERS AND RESEARCHERS WITHIN CSIR BUILT ENVIRONMENT UNIT

The purpose of this research is to obtain perspectives regarding the social relevance of science and technology (S&T) produced by science councils, as well as, providing evidence regarding the selection and decision making processes used in science councils to identify S&T projects.

These questions are directed at R&D managers and researchers within the Council for Scientific and Industrial Research (CSIR) in South Africa.

a. **BIOGRAPHICAL INFORMATION**

Date: _____

Location: _____

Interviewee's Name: _____

Interviewee's Role: _____

Interviewee's Gender: _____

Highest level of Education: _____

b. **PROJECT BACKGROUND**

1. Have you been involved in a water provision project before?

☐ *Yes* ☐ *No*

If yes, which project was this?

2. What was your role in the project?

3. What was the scope of the project?

c. **POWER AND DECISION MAKING**

4. Who decides on the projects that should be taken up by the CSIR Built Environment Operating Unit?
   - How was the water provision project decided upon?
   - How was the scope of the project decided upon?

5. Which key stakeholders were involved in this project?
   - What was their role in the project?

6. How is S&T output aligned with user needs?

d. **PROJECT FUNDING**

7. How was the project funded?
   - Who provided funding for the project?
   - How was the funding sourced/ secured?

8. How is value for the money invested in the project ensured?

9. Is there consideration of how the project will support the quality of life of the users?

☐ *Yes* ☐ *No*

   - If yes, how was that done in this specific project?

e. **USER INVOLVEMENT**

11. How does the CSIR define users?

12. Was there any involvement of the users in the project?

☐ *Yes* ☐ *No* ☐ *Uncertain*

   - If yes, at what stage of the project were they involved
   - What was their role in the project?

13. In your opinion what are the expectations of the users from the CSIR?

   - How important is it to deliver on these expectations?

   - Do you ever find contradiction between user expectations and the requirements of the research funders?
     - If yes, how are these dealt with?

f. **RELEVANCE**

14. In your opinion, is the S&T produced by the CSIR Built Environment Unit relevant?
    - If so, how?
    - How is relevance of S&T output measured in the CSIR?
    - Are there specific indicators used to assess relevance?
        - If yes, what are they?
    - Do you think these indicators address social needs?
        - If so, how?
    - How do relevance assessment results influence future S&T output by the CSIR?

15. What do you think can be done to improve the relevance of S&T produced by science councils in South Africa?

Thank you for participating in this study.