An RDI Value Framework

A framework toward empowering research institutions to deliver demonstratable value to their stakeholders

Volume 1: Review of theory and situational analysis

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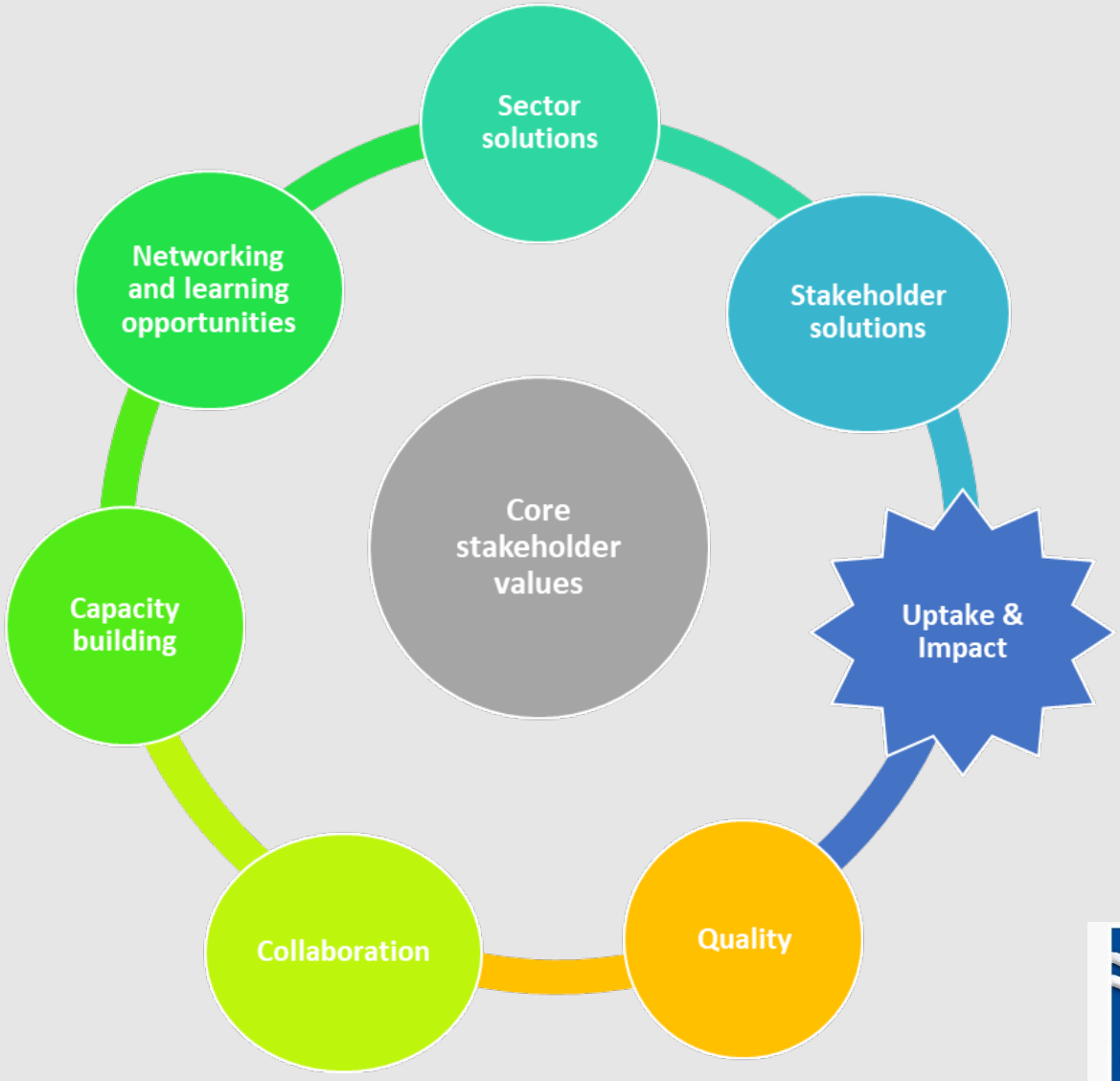

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Executive Summary

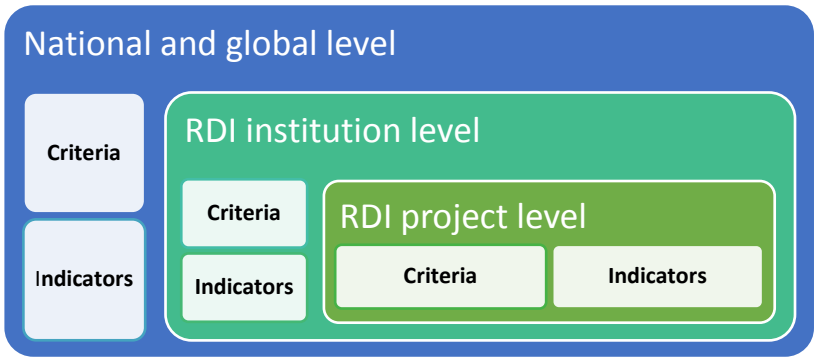
Globally, water research organisations grapple with the same challenge:

> *In some cases, research and innovation are conducted to produce new knowledge and innovations that are poorly, or not taken up by the water and sanitation sector or industries.*
> (Quote from Terms of Reference of this study)

The research team was tasked to address this challenge with the South African Water Research Commission (WRC) as a case study. The study forms part of an initiative of the Global Water Coalition (GWRC), of which the WRC is a member.

A comprehensive literature review provided the theoretical background. It found the following:

- The reviewed Research, Development & Innovation (RDI) frameworks set criteria for RDI outputs (and inputs) and identify associated indicators that the criteria have been met. Input criteria relate mostly to resources and other requirements for an environment that supports and encourages innovation. Output criteria relate to aspects like quality, relevance and what is perceived as the benefits of RDI (for example, socioeconomic or environmental benefits).
- Most of these RDI frameworks are evaluative, that is, the indicators are used to measure if, and to what extent, the criteria have been met. However, some RDI frameworks are facilitative in the sense that they assist projects or organisations to meet the criteria. For example, the Research Impact Toolkit, discussed in the literature review, is a facilitative RDI framework that includes mechanisms to actively plan for uptake and impact. It was interesting to note that the National Research Foundation has recently adopted a facilitating approach to impact realisation.
- The performance of individual research projects on RDI criteria and indicators can be aggregated to the level of the research institution, whose RDI outputs ultimately contribute to the national and global RDI indices, as the figure illustrates.



The research subsequently analysed the WRC's mission and vision statement, and annual reports, to determine how the organisation is structured to deliver value to its stakeholders. The research also summarised the findings of the stakeholder research that the WRC has done in the past.

These findings, plus the insights gained from the literature review, informed the first round of stakeholder engagements. Thirty stakeholders of the WRC, including project stakeholders from a sample of six WRC projects, were interviewed to understand what they perceive as the value of RDI and how they would describe the value that WRC RDI projects have delivered or not delivered to them.

The first round of stakeholder research found that the value that stakeholders ascribe to water and sanitation RDI is multifaceted and looks different for different groups of stakeholders. The research found overlaps in both value and indicators, but this overlap does not run across all representatives of a stakeholder group, nor does it run across all stakeholder groups.

Some stakeholder values, like sector solutions, are delivered, or expected to be delivered, at research project level; some at the level of the research institution (for example a mechanism to coordinate water research in South Africa); and some at national level (for example, regulatory and policy measures that support innovation).

Despite the diversity, seven core stakeholder values (see figure below) could be extracted and related to the literature.

Their associated indicators at national, institutional and project level could also be aligned with the literature. (It is acknowledged that for other members of the GWRC, the core stakeholder values might look different.)

However, the value or benefits which end-users and beneficiaries ascribe to water and sanitation RDI, and the associated indicators, were found to be project specific.

The next task was to develop a water and sanitation RDI framework for the WRC based on these seven core values and the insights from the literature review and stakeholder research. Since this Framework must capacitate Project Leaders and Research Managers to unlock the full value of RDI projects for stakeholders, the research team called it an RDI Value Framework.

The draft Framework was presented to the GWRC during an online workshop on 20 January 2022.

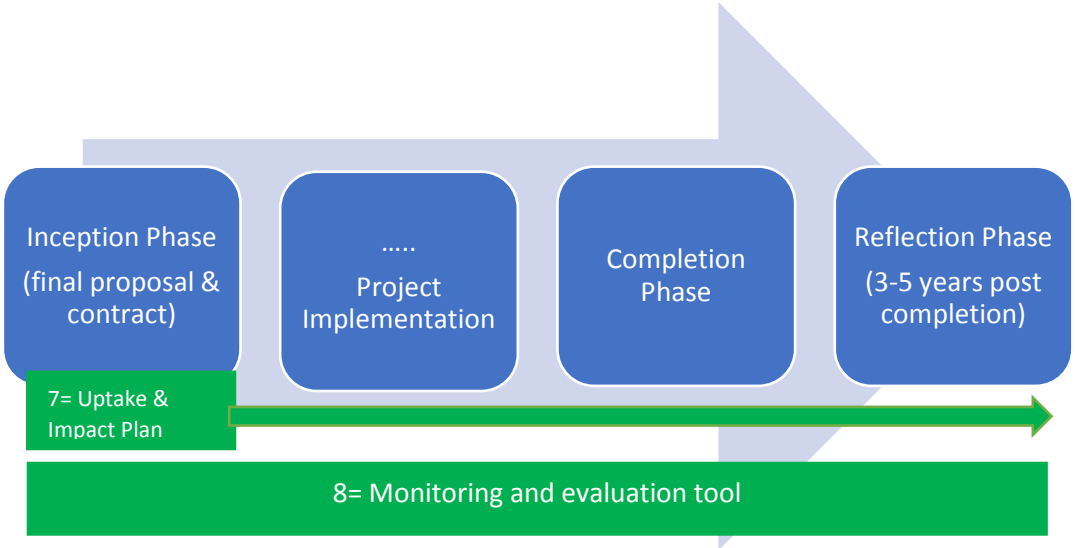
The guiding principles in developing the Value Framework were the following:

- Stakeholder value, as defined and described in the literature review, is the main pillar of the Framework, and it was also the starting point from where the Framework was developed.
- The concept that RDI can be planned to realise stakeholder value is a core element of the Value Framework. Specifically, the concept that RDI can, and should plan, for uptake and impact.
- The Framework should provide for tracking, analysing, monitoring, and evaluating stakeholder value across the full value chain of RDI. It should also deliver insights that enable the research institution to learn and improve. In other words, it should be dynamic and flexible.
- The value that certain stakeholder groups attach to water RDI might change over time. This will have to be captured in regular stakeholder research and the Framework adjusted accordingly.

Developing the Value Framework entailed the following steps:

1. Developing subcategories for the seven core values and identifying their associated indicators and high-level metrics
2. Integrating stakeholder value across the full project life cycle. It is proposed that the templates of the WRC's current planning, management, and evaluation (PME) tools, starting from the project proposal to the final Research Manager's report, be aligned with the core stakeholder values and their indicators.
3. Adding a Reflection Phase, which provides for stakeholder value to realise three to five years after the Completion Phase.
4. Adding two new PME tools: an Uptake & Impact Plan and a Monitoring & Evaluation (M&E) Tool. The proposed Uptake & Impact Plan plans for RDI uptake and impact and tracks progress and performance against a set of SMART indicators. The proposed M&E Tool monitors and evaluates the core stakeholder values and the associated indicators across the full project life cycle.

   The two proposed new PME tools extend from Inception until Reflection as the figure below illustrates.



The draft Framework was presented to 16 stakeholders of a sample of a further six WRC projects to obtain their input. The draft M&E Tool was tested with the Project Leaders of these six projects and subsequently refined.

It is proposed that all the PME tools use the same template format, which eventually could be web-based and integrated into the proposed M&E Tool.

The metrics of the proposed M&E Tool will provide the research institution with a rich diversity of insights that could be used for multiple management and reporting purposes. These include feeding data into the KPIs of the research institution and global innovation indices.

Applying the RDI Value Framework will furthermore empower the research institution to integrate stakeholder value into its operational processes. Drawing on the statistics and insights that the M&E Tool can offer, coupled with impact stories, the Framework will empower the research institution to report, and demonstrate, to stakeholders the value that its projects have realised.

Acknowledgements

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We would also like to thank all the stakeholders of the WRC who were consulted for your time and your valuable contributions to shape this research. These include:

Internal stakeholders:
Mr Dhesigen Naidoo (CEO, WRC)
Dr Valerie Naidoo (WRC)
Dr Mandla Msibi (WRC)

Research partners:
Representatives from DWS, Department of Science and Innovation, SALGA, CSIR, Umgeni Water, Universities SA

Project stakeholders (Research managers, Project leaders, Reference Group members, students, and beneficiaries) of the following WRC projects:

1. WATCOST: manual for a costing model for drinking water supply systems
2. MiniSASS Data Management: development of an online map-based data portal (three projects)
3. Development of a framework for franchising in the water services sector in South Africa (more than one project)
4. Electric power supply measurement as an alternative to measure flow rates of hydraulic pumps
5. A feasibility and implementation model of small-scale hydropower development for rural electrification in South Africa
6. Demonstration and scaled-up implementation of pour-flush sanitation in South Africa
7. Data Magic: Using R and R marked down for water quality data science
8. Buffer Zone guidelines for wetlands, rivers, and estuaries (Part 1 and 2)
9. Design of Acid Mine Drainage Remediation Plant
10. Responsive Pipe networks
11. Water Use of Agroforestry systems for food and forage production
12. Case Study to Document Bio-Char Technology for Faecal Sludge Treatment and Beneficiation in East London.

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List of Acronyms

APP	Annual Performance Plan
BDI	Business Development & Innovation
CBA	Cost Benefit Analysis
CESA	Consulting Engineers South Africa
CSIR	Council for Scientific and Industrial Research
DM	District Municipality
EIB	European Investment Bank
EU	European Union
GWRC	Global Water Research Coalition
I&I	Innovation and Impact
IP	Intellectual Property
IRS	Innovation Radar Survey
KPI	Key Performance Indicator
KSA	Key Strategic Area
LM	Local Municipality
M&E	Monitoring and Evaluation
MoU	Memorandum of Understanding
N/A	Not applicable
NGO	Non-Government Organisation
OECD	Organisation for Economic Co-operation and Development
PME	Planning, monitoring and evaluation
RAAIS	Rapid Appraisal of Agricultural Innovation Systems
R&D	Research and Development
RDI	Research, Development and Innovation
R&I	Research and Innovation
ROI	Return On Investment
SANBI	South African National Biodiversity Institute
SASTEP	The South African Sanitation Technology Enterprise Programme
SASS	South African Scoring System
StatsSA	Statistics South Africa
TAF	Technology Applicability Framework
TIA	Technology Innovation Agency
TIP	Technology Introduction Process
TOR	Terms of Reference
TRL	Technology Readiness Level
U&IP	Uptake & Impact Plan
UWA	University of Western Australia
VIPs	Ventilated Improved Pits
WADER	Water Technologies Demonstration Programme
WISA	Water Institute of Southern Africa
WRC	Water Research Commission
WSA	Water Services Authority
WTA	Willingness to Accept
WTP	Willingness to Pay
WUA	Water User Association

Chapter 1: Introduction

1.1 STRUCTURE OF THE REPORT

The project report comprises two volumes.

Volume 1 (this document) covers:

- A review of the theory, and
- A situational analysis that includes research on stakeholder value in past WRC projects and a first round of stakeholder research.

Volume 2 covers:

- The development of an RDI Value Framework and practical tools to facilitate, monitor, evaluate and report on stakeholder value derived from RDI
- A second round of stakeholder research, and
- Conclusions and recommendations.

1.2 BACKGROUND

This study forms part of a larger research project, called "Valuation of water Research and Innovation". The larger project is an initiative of the Global Water Research Coalition (GWRC), of which the Water Research Commission of South Africa is a member. GWRC members discuss, engage, and initiate projects that advance Research, Development and Innovation in water and sanitation which address common challenges or interests. The WRC's participation in this initiative required the WRC to initiate a case study focusing on South Africa (involving key stakeholders of the WRC).

The Terms of Reference (ToR) of this study described the research problem as follows:

> *In some cases, research and innovation are conducted to produce new knowledge and innovations that are poorly or not taken up by the water and sanitation sector or industries.*
>
> *One of the cause factors for this is the poor participation by the stakeholders (industries and public) in defining and expressing their needs with regard to RDI knowledge and innovation. This has resulted in the failure or lack of appreciation for the important roles that are played by water and sanitation research institutions. In some cases, opportunities and benefits from research are overlooked and never used to address challenges faced by communities in need or by the water sector.*

1.3 OBJECTIVES OF THE STUDY

According to the ToR, this study should:

1. Review and understand WRC's stakeholders' views and perception about value of WRC's research products and services.
2. Understand what WRC's stakeholders perceive as 'value' coming from research, development and innovation.

3. Investigate if funders and the public (taxpayer) perceive to be getting value from water and sanitation research and innovation.
4. Identify how and where investments in water research and innovation provide value, as perceived and recognized by the primary users and funders of the research and innovation activities,
5. Work with other GWRC members to develop a range of metrics that can be used to guide WRC and its stakeholders' assessment of the value of water and innovation research activities within our respective contexts.

1.4 AIMS OF THIS STUDY

These general objectives crystallised into the aims of the South African case study as follows:

1. To investigate the concept of ''value'' with reference to research, development and innovation (RDI) in water and sanitation from the perspective of the relevant WRC stakeholders
2. To engage with stakeholders and develop an approach and methodology, including appropriate indicators (metrics), to plan, monitor and evaluate the value that the WRC's RDI projects deliver to stakeholders
3. To develop an instrument for RDI that could become part of the WRC's standard operating and reporting procedures and test it against the selected projects.

1.5 ''VALUATION'' AND THE SCOPE OF THE STUDY

According to the Oxford dictionary[1], the term "valuation" refers to the assessment and estimation of worth (usefulness and importance). Valuations are often based on an estimated monetary value.

This study aims to, not only assess the value (usefulness and importance) that the WRC's stakeholders ascribe to RDI, but also to develop a framework and associated planning, monitoring and evaluation (PME) tools to unlock stakeholder value.

The term ''evaluation framework'' is therefore too narrow for this study. Plus, as will be discussed in the literature review, not all RDI frameworks are structured to assess value; some are structured to facilitate uptake and impact to unlock value.

For this reason, this study will use ''RDI frameworks'' as the broader term.

[1] https://www.oxfordlearnersdictionaries.com/definition/english/valuation

Chapter 2: Literature review

2.1 INTRODUCTION

The literature review discusses, firstly, the definitions of the fundamental concepts of this study:

- Research, development and innovation (RDI)
- The value of RDI – what does it mean?
- What constitutes RDI value in the water sector?

Secondly, the chapter reviews literature on evaluating frameworks for RDI projects, RDI institutions, and innovation at a macro level. Planning for value is a relatively new approach. Literature on frameworks to facilitate uptake and impact are also reviewed.

Resources were selected on the following basis:

1. Available on the internet and visible in Google and Google Scholar searches
2. Comprises one of the keywords of "innovation'', ''RDI'', ''value of RDI'', ''value indicator'', RDI evaluation'', ''value of an RDI project'', ''value of investment in RDI'', ''indicators of RDI value'', ''water and sanitation'' in the title, abstract or full text.
3. Reports of international organisations like the OECD and the European Union
4. Peer-reviewed journal articles
5. Published after 2000
6. Articles in English
7. Articles focusing on, or relevant for, RDI projects and RDI institutions
8. Articles considering ex post evaluations and learning evaluations.

The chapter concludes with an overview of the literature that sets out the Water Research Commission of South Africa's mandate and its evaluating and facilitating frameworks. This will set the context against which the primary research will take place.

2.2 DEFINITIONS OF RDI

Before we review literature on the evaluation of RDI activities, we will briefly touch on the basic definitions, as they underlie the evaluation criteria and even the evaluation methodologies. The typologies are also valuable for the selection of a sample of WRC RDI projects to be investigated in this study.

2.2.1 What is Research & Development (R&D) and how is it different from RDI?

A paper from the National Science Foundation of the USA (Moris, 2018) quotes several definitions of R&D. Most of the definitions are aligned with the OECD definition as found in the Frascati Manual of 2015 (OECD, 2015):

> *Research and experimental development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge—including knowledge of humankind, culture and society—and to devise new applications of available knowledge.*

The Frascati Manual (OECD, 2015) defines three types of R&D:

1. **Basic research**: experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.
2. **Applied research**: original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective.
3. **Experimental development**: systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes.

According to Dunnet et al. (2007), RDI refers to ''the whole process of generating new knowledge and turning it into productive economic activity'', and is a slightly broader concept than R&D. Dunnet et al. (2007) classifies RDI in terms of stages of the innovation cycle – see the figure below:

Innovation Cycle	RDI Scale	
	Stage	Description
Research	1	Intellectually-driven investigation with no foreseeable economic application.
	2	Investigation within established disciplines/technologies.
	3	Applied research within existing technology boundary with practical applications in mind.
Development	4	Technology 'start-up' to develop practical applications for research ideas.
	5	Collaborative development within existing industries to produce new or next generation technology.
	6	Technical development of products following a defined longer-term technology 'roadmap'.
Innovation	7	Development of 'new generation' products involving substantial modification/innovation.
	8	Process/product innovation designed to modify/improve/differentiate existing products.
	9	Process innovation designed to reduce cost or extend life of existing product range.
Not RDI	10	Investment in maintenance or expansion of existing production.

Figure 2.1: RDI scale in terms of stages of the innovation cycle

However, novelty or innovation is not an add-on or a stage as the above figure might suggest; it is integral to R&D. R&D involves the creation of new knowledge. Dunnet et al. (2007) defines 'Research' as ''the curiosity-driven process of discovering new knowledge'', 'development' as ''the deepening of new knowledge with a view to developing a practical application'', and 'innovation' as "the process of using new knowledge to improve existing applications''. The authors concede that any attempt to depict the innovation cycle in a linear way as in the figure above is an oversimplification.

Relevance for this study
The classification of Dunnet et al. (2007) was used to classify the WRC projects sampled for this study. However, when applied, it was evident that the scale was not appropriate for non-technological RDI. See example 4 in 2.3.4.

2.2.2 The evolution of the term ''innovation''

In the literature, the terms ''research'' and ''development'' within the RDI framework, seems to be less controversial and less of a point of discussion than ''innovation''. An overview of typologies of innovation in the next section will show how the scope of the term ''innovation'' has evolved and broadened over time.

2.2.3 RDI and economic theory

Van Beers et al. (2015:5) discusses the impact of economic theories on perspectives on the role of innovation in economic development. The pathway of economic theory and that of innovation theory runs parallel.

According to mainstream economics, classical and neo-classical economics focused on optimising innovation, through rational and linear action. Evolutionary economics, on the other hand, holds a more organic and systemic view of innovation, in which outcomes and impact are uncertain (Van Beers et al., 2015: 9).

2.3 A TYPOLOGIES OF INNOVATION

The literature discusses several typologies of innovation. The subsections below explore a few relevant typologies that could be useful for the selection of WRC RDI projects to evaluate in this study. The link between typologies and the evolution of economic and innovation theory is evident.

2.3.1 Technological vs non-technological vs social innovation

The Oslo Manual (OECD, 2015:29) defines **technological innovation** as ''new and improved products and processes". Havas (2016) questions the emphasis on products in innovation literature such as Dunnet et al. (2007) but agrees that innovation is a solution that is introduced to the market. In other words, an idea with a proven, practical use.

The Oslo Manual (OECD, 2015: 89) defines **non-technological innovation** as ''all the innovation activities of firms which do not relate to the introduction of a technologically new or substantially changed good or service or to the use of a technologically new or substantially changed process''. The major types of non-technological innovation are organisational and managerial innovation.

Van Beers (2015) notes that the Oslo Manual is focused on businesses and not on civil society organisations, which is the reason why **social innovation** is not addressed. Social innovation is defined in the same publication as "the development and delivery of new ideas (products, services, models, markets, processes) at different socio-structural levels that intentionally seek to improve human capabilities, social relations, and the processes in which these solutions are carried out" (Van Beers et al., 2015). In other words, social innovation refers to the impact of the innovation and not the nature of the innovation.

Havas (2016) notes that although social innovations can rely on technological innovation, they mostly lead to organisational, managerial and behavioural changes, which are not normally measured as indicators of technological innovation.

Geissdoerfer et al. (2017) makes the point that businesses have in recent years extended their goals beyond economic performance to include environmental sustainability and social inclusion. The achievement of these goals requires not only new technologies, but also innovative business models, in other words, a new type of innovation.

Ziegler (2019) disagrees. According to Ziegler (2019), the impact on social inclusion is seldom mentioned in literature on the circular economy[2]; so are business models as enablers of the circular economy.

The term ''**democratic innovation**'' is linked to social inclusion and refers to ''institutions designed explicitly to increase and deepen citizen participation in political decision-making'' (Smith, 2019:4).

In the same vein, Ziegler (2019) broadens the scope of the term ''innovation'' to include social creativity. The question is asked:

> *Are the water retention measures of People and Water or the decentralised freshwater provisions of IKT[3] 'really' innovative? They do not emerge from a search for novelty and profits, nor do they point to technical novelty. Rather, they emerge as creative social responses to what are perceived as the dominant political and economic tendencies – responses which use new network building and the reframing of issues.*

Ziegler (2019) takes this reasoning a step further by citing the Reformation as an example of a social movement that is innovative in its counter-innovation drive to restore the original and ''true'' state of the Christian church.

In terms of these classifications, a WRC RDI project could therefore fall in one (or more) of the following:

Table 2.1: Innovation types

Type	What is new?	Result
Technological innovation	New product	Economic benefits (profits, ROI, etc.) Social benefits (greater inclusivity, etc.) Environmental benefits
	New process	
	New service	
Non-technological innovation	Organisational change	
	Management change	
	Behaviour change	
	A new market or market innovation	
	New business or organisational model	
	A creative social response to the dominant political and economic tendency	
	Reversing a previous innovation	

[2] Kirchherr et al. (2017: 227) in their review of definitions of the circular economy found that the concept is most frequently depicted as a combination of reduce, reuse and recycle activities.

[3] Interest community for communal drinking water provision in Bavaria, Germany.

Havas (2016) notes that technological and non-technological innovation often go hand in hand:

> *…technological innovations simply cannot be successful without applying some sort of non-technological ones. (Pavitt, 1999; Tidd et al., 1997) In particular, radical innovations often create new markets and that is, by definition, a market innovation.*

2.3.2 Innovation agents

Traditionally, the following agents are involved in technological RDI:

- Private sector: businesses
- Academic or research institutions, and
- Governments/agencies

Ziegler (2019) uses the term ''grassroots innovators'', meaning civil society associations and interest communities. Grassroots innovation has no monetary profit and investment motive (Ziegler, 2019). Grassroots activism manifests typically as networks for exchange of experiences and coordination of some social actions due to economic circumstances. The emphasis is on social learning instead of scaling up products or services.

Even more radical is the inclusion of nature as a role player in innovation (Ziegler, 2019) via the concept of nature-based solutions, that is finding inspiration from novelty and creativity in nature, for example by mimicking natural processes. Examples of such nature-based solutions include green roofs for rainwater retention, restored or constructed wetlands for nutrient and water retention, and vertical greening of houses for cooling. Ziegler (2019) notes that ''all innovations, whether in or across communal, public and market provision, can be inspired by or supported by nature''.

For the purpose of this research, we used following classification:

Table 2.2: Innovation agents

Innovation agents
Private sector: businesses[4]
Academic or research institution
Government/agency/state-owned enterprise
NGOs
Civil society associations and interest groups
A combination of the above

[4] These include companies whose business is RDI, for example consultancies. It could even be independent consultants, operating as individuals.

2.3.3 The typology of the WRC

In contrast to the typologies discussed above, the WRC classifies its RDI projects in terms of the organisation's management structure (branches and business divisions). See the figure below.

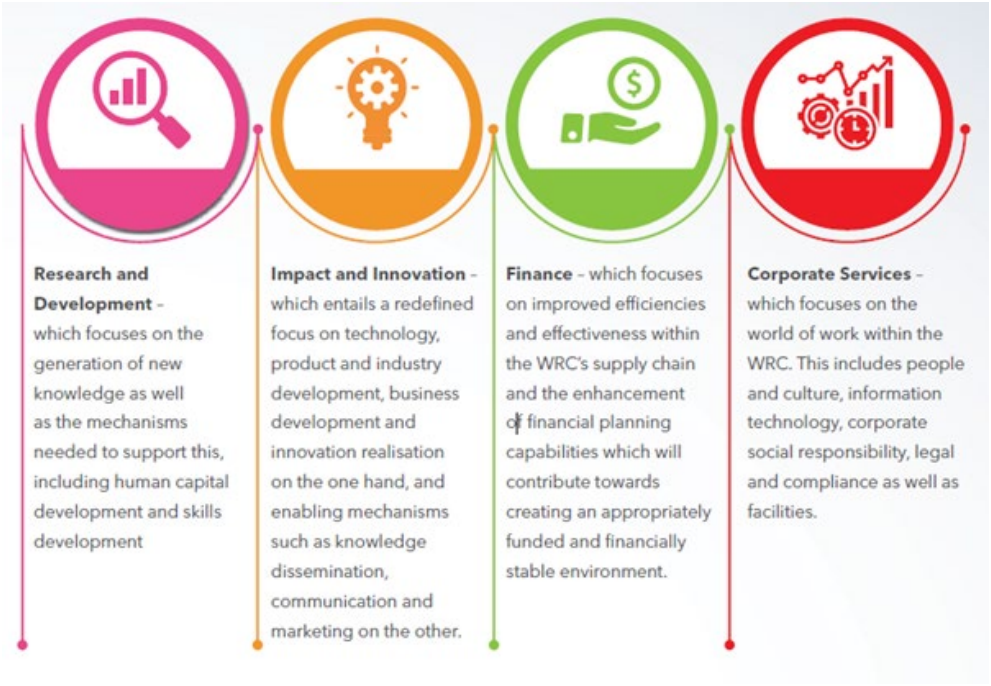


Figure 2.2: Business divisions (branches) of the WRC (WRC, 2018)

The Impact and Innovation division/branch (I&I) was established to improve uptake and impact. For this reason, it focuses on the end stages of the innovation cycle. Since the publication of the Corporate Plan for 2018-2023, the I&I branch was split into Business Development and Innovation and International Cooperation and Partnerships.

The business divisions or key strategic areas (KSAs) of Research and Development, as well as the focus areas of each, reflect the institutional framework of the water sector in South Africa, national policies and strategies, and national and international development goals. See the figure below.

KSA 1&2 Water Resources and Ecosystems	KSA 3 Water use, wastewater resource and sanitation futures	KSA 4 Water Utilisation in Agriculture
•Thrust 1: Governance and Institutional arrangements •Thrust 2: Hydrological and Ecosystem processes •Thrust 3: Water resource and Ecosystem protection and utilisation •Thrust 4: Environmental change and adaptation •Thrust 5: Resource quality and management •Thrust 6: Water Resource Innovation and Technologies	•Thrust 1: Water sensitive and resilient settlements •Thrust 2: Water quality futures •Thrust 3: Sustainable integrated wastewater resources futures •Thrust 4: The sanitation transformation initiative	•Thrust 1: Water utilisation for food, forage and fibre production •Thrust 2: Water utilisation for fuelwood and timber production •Thrust 3: Water utilisation for poverty reduction and wealth creating in agriculture •Thrust 4: Water resource protection, restoration and reclamation in agriculture

Figure 2.3: The WRC's key strategic areas (KSAs) (WRC, 2021)

Each RDI project is therefore associated with the Research and Development branch and fall within a KSA and focus area. RDI projects are further classified into research thrusts and programmes, which are more finely defined content areas.

In addition, some RDI projects fall under the Business Development and Innovation branch. These projects aim to apply, test, improve and demonstrate innovations.

The WRC classifies the maturity of technology projects according to Technology Readiness Levels (TRLs):

Table 2.3: Technology Readiness Levels

TRL1	Basic research	An innovative principle was observed and reported on. The innovation is an idea. The observation cannot be reproduced or applied as yet.
TRL2	Proof of principle	The innovation concept and/or application has been formulated and it is possible to demonstrate parts of or the entire innovation.
TRL3	Early lab scale demonstration	Partial proof of concept achieved. A laboratory-scale demonstration was possible. May not be reproducible yet.
TRL4	Late lab scale	Lab scale validation of proof-of-concept through a trial, and/or input received from an external source. Innovation is reproducible.
TRL5	Validation	Broader trial or validation of the proof of concept is achieved. Can include early-stage commercial demonstration.
TRL6	Early prototype	The early-stage prototype can be fully or partially demonstrated in its relevant environment of use (possibly in a commercial setting). It is not a complete prototype. Learnings and iterations still ongoing.
TRL7	Late prototype	The prototype can be demonstrated in its relevant environment of use (possibly in a commercial setting). The prototype is nearer to completion. Fewer learnings and iterations are needed.
TRL8	Early-stage commercial	Innovation being tested or has been completed in its commercial environment. Learnings and iterations applicable to its commercial use are still generated.
TRL9	Market ready application	Innovation is being used in its intended commercial setting. There is proven commercial use. Fewer iterations are being done, if so then they are minor.

2.3.4 Typologies for this research

Five typologies were initially used in this research to classify WRC projects:

1. WRC research area
2. Position on the RDI scale, and the TRL (see tables above).
3. Technological versus non-technological projects
4. Nature of the intended impact (social, economic, environmental benefits)
5. Innovation agent(s).

The WRC's RDI projects cover the full spectrum of innovation types as the four examples below illustrate.

1. **MFC Municipal Sludge Treatment**
   A set of plant microbial fuel cells to treat municipal sludges while producing power. This innovation essentially turns municipal sludge beds into bio-power plants.

WRC research area	KSA 3: Water use and waste management
Position on RDI scale	Stage 2 (Research): Investigation within established disciplines Further development work is required in order to validate the concept for the proposed innovation. (TRL 3)
Technological or non-technological	Technological: New process
Intended impact	Economic benefits Environmental benefits
Innovation agent(s)	Academic sector: University of Cape Town

2. **Competitive Small-scale Solar Desalination**
   A low-cost portable water purifier and desalination device powered by renewable energy.

WRC research area	KSA 3: Water use and waste management
Position on RDI scale	Stage 3 (Research): Applied research within existing boundary with practical applications in mind. Proof of concept validated through laboratory scale trials. Partnerships and further funding are required to demonstrate the technology in a relevant environment. (TRL 4)
Technological or non-technological	Technological: New product
Intended impact	Economic benefits Environmental benefits
Innovation agent(s)	Academic sector: University of Cape Town

3. **Participatory Hydrological Modelling – Theory U**
A complex spatial hydrological model has been developed based on the Theory U, which includes both social and ecological systems. The development of the proposed model intentionally included all concerned stakeholders, from the developers and, importantly, the ultimate end users.

WRC research area	KSA 1 & 2: Water Resources and Ecosystems Innovations
Position on RDI scale	Stage 9 (Innovation): Process innovation designed to reduce cost or extend life of existing product range Currently being implemented by research team. (TRL 9)
Technological or non-technological	Non technological: New business or organisational model
Intended impact	Environmental benefits Social benefits
Innovation agent(s)	NGO: Living Lands Government Civil society associations and interest groups

4. **The use of role-playing games to train smallholder farmers on entrepreneurial development paths**

WRC research area	KSA 4: Water utilisation in agriculture
Position on RDI scale	Non-technological innovation in pilot stage. Difficult to plot on RDI scale. No plan to commercialise, but plan to extend use Stakeholder workshops have been conducted in three provinces, involving government officials, famers and representatives of different private sector entities. Partnerships are sought to disseminate research finding to farmers through this approach. The WRC will seek additional funds to rollout the game to more communities to strengthen entrepreneurship. (TRL 6)
Technological or non-technological	Non-technological: Behaviour change
Intended impact	Economic benefits Social benefits
Innovation agent(s)	NGO: Institute of Natural Resources Private sector entities Government officials

Given the finding in Example 4, it was decided to only use the TRL scale in this research, and only for technological projects.

2.4 THE VALUE OF RDI

2.4.1 Introduction: the concept of value

The Oxford dictionary gives two definitions for the term "value". Firstly, value(s) can be defined as "principles or standards of behaviour; one's judgement of what is important in life". The second definition is: "the regard that something is held to deserve; the importance, worth, or usefulness of something".

The Terms of Reference (TOR) for this study states that the study should engage with stakeholders to understand **''what our stakeholders recognise as value in the WRC's RDI programmes''**. The focus of this study is therefore on the second definition of value. In the commercial space, the value of RDI is commonly referred to as Return on Investment (ROI). In the development space, the value of RDI is commonly referred to in terms of uptake/adoption and impact.

Previous WRC research has found (Slabbert, 2016; Van der Merwe-Botha, 2017; Van der Merwe-Botha, 2018; Slabbert et al., 2019) that:

1. Stakeholders have different needs; different expectations and different interpretations of ''value''
2. In the RDI space, ''value'' is also project-specific and depends on the type of output of the project. For example, a product that can be patented; a strategy; a regulatory or governance tool; data; a method or process.

2.4.2 Value categories

What would it mean for a stakeholder to say that the WRC's RDI programme, or a specific RDI project, offers or creates value? This will be explored in the first round of stakeholder research – see Chapter 3.

The literature categorises ''value'' in different ways. For example, Groenfeldt (2019) draws up the following value matrix for value in water.

	Economic value	Social value	Environmental value	Cultural value	Governance value
Water ecosystems					
Water use					

Although economic value is often the central value of RDI output and impact, it is certainly not the only value. In some RDI frameworks, it is not even regarded as the most important value (Feitelson, 2017).

Economic value is defined by the European Commission (2014: 365) as ''the monetary measure of a change in an individual's well-being''. The total economic value of a resource is made up of its use value plus its non-use value, i.e. total economic value = use values + non-use values.[5] It should be noted that social, environmental, cultural and governance value could also have economic value.

[5] Use value: social value people have from actually using a good or potentially using it in the future.
Non-use value: each individual could be assumed to place a value not only on the well-being produced by the good's existence per se on himself/herself (existence value), but also on the well-being caused to other individuals by the availability of that good, either in the same generation (altruist value) or future generations (bequest value).

If one looks at UN Water's description of the value of water, it is clear that water embodies the full spectrum of values.[6]

> *Water is at the core of sustainable development and is critical for socio-economic development, healthy ecosystems and for human survival itself. It is vital for reducing the global burden of disease and improving the health, welfare and productivity of populations.*
>
> *Water is also at the heart of adaptation to climate change, serving as the crucial link between the climate system, human society and the environment. Without proper water governance, there is likely to be increased competition for water between sectors and an escalation of water crises of various kinds, triggering emergencies in a range of water-dependent sectors.*
>
> *The physical world of water is closely bound up with the socio-political world, with water often a key factor in managing risks such as famine, epidemics, inequalities and political instability.*

This implies that water RDI projects have the potential to deliver or create value across all five value categories.

In the RDI frameworks discussed in the next section, ''**benefit'**' and ''**value**'' are used interchangeably.

2.4.3 Uptake and adoption

The adoption or uptake of an innovation refers to a specific action that the intended end-user of an innovation has to take to unlock its value or benefit. In the field of agricultural innovation, uptake or adoption of innovation is often regarded as the desirable state or per se beneficial (Slabbert et al., 2019). But adoption or uptake of an innovation might not necessarily be to the benefit of users.

Also, the lack of benefit or value to end-users does not exclude the benefits that other stakeholder categories, for example the researchers/innovators may have gained from their involvement in the RDI initiative. These benefits could range from monetary to intellectual benefits, which could lead to follow-on RDI activities.

2.4.4 Impact

The Australian Research Council defines the impact of RDI as: ''the demonstrable contribution that research makes to the economy, society, culture, national security, public policy or services, health, the environment, or quality of life, beyond contributions to academia'' (Australian Research Council, 2013:45).

The Grassroots Development Framework (Pasteur, 2002) distinguishes the following categories of impacts, ranging from tangible impacts to intangible impacts:

[6] https://www.unwater.org/water%20facts/

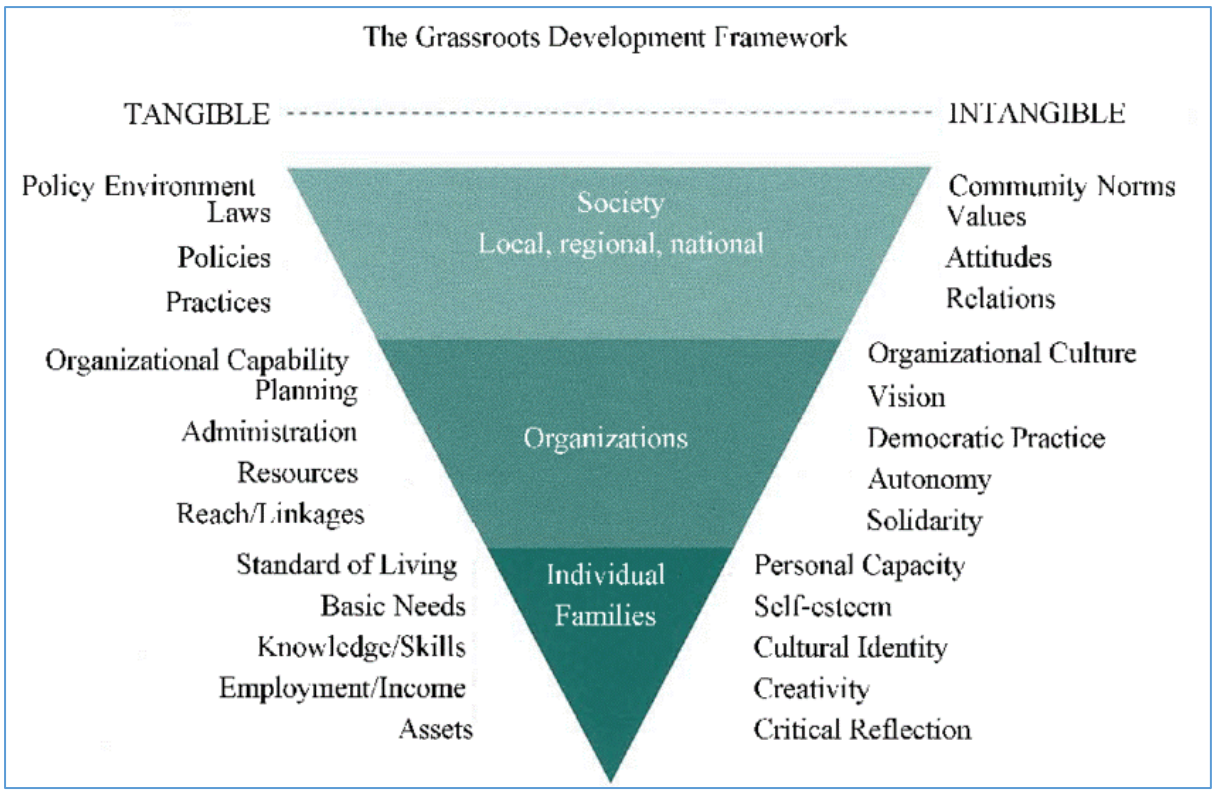


Figure 2.4: Categories of impacts (Source: Inter-America Foundation[7])

In the corporate space, there has been an increasing awareness of the impact that business activities have on social and environmental sustainability. The triple bottom line accounting framework was developed to extend the traditional measures of profits, return on investment and shareholder value to include social and environmental impact (Elkington, 2013). The three dimensions are referred to as Profits, People and Planet, or the 3Ps. The ESG (Environment, Social, Governance) Model has also become popular in the modern business environment. The Model comprises a set of environmental, social and governance criteria for a company's operations[8]. Keppler (2022) describes the triple bottom line as "ESG without the G— it's about environmental and social aims with financial objectives"[9].

The definitions of social and environmental impact and the measurement of impact in the corporate space run parallel to those of impact in the RDI space.

Relevance for this study (
In view of the above definition and interpretation of impact, ''value'' (or ''benefit'') is, for the purpose of this study, the broader concept. Impact is a type of value or benefit that affects the well-being of society (Barnes, 2015). .

[7] https://www.iaf.gov/what-we-do/publications/grassroots-development-framework/

[8] https://www.investopedia.com/terms/e/environmental-social-and-governance-esg-criteria.asp

[9] https://economictimes.indiatimes.com/news/et-evoke/the-triple-bottom-line-is-better-than-esg-to-measure-a-companys-financial-environmental-and-social-performance/articleshow/89165160.cms

2.4.5 Evaluating RDI performance

Effective and efficient research and innovation systems are those that succeed in producing strong scientific, technological and innovation outputs, both in terms of quality and relevance, to address societies' economic and social challenges. (European Commission, 2017:8)

Havas notes in Van Beers et al. (2015) that it is not straightforward to find the most appropriate way to assess R&D and innovation performance.

In a similar vein, Clarke et al. (2013) concedes that many benefits of RDI projects are difficult, if not impossible to measure:

- Some benefits are intangible, for example the diffusion of new knowledge
- Some benefits are uncertain, or might not materialise at all; others might fail or exceed expectations
- Some benefits may have a far wider reach over time than could be predicted.

The Oslo Manual (OECD, 2018) points out that the value for private enterprises and the public good as pursued by governments overlap: The benefits of innovation for private enterprises tends to spill over into the public good in as far as they benefit citizens and communities directly or indirectly.

The Oslo Manual (OECD, 2018) comments that even though value-related measures are important to facilitate understanding the impacts of innovation, there is no single measure of economic or social value in established statistical frameworks such as the SNA (System of National Accounts, 2008). By its nature, realising the value of an innovation is uncertain and can only be fully assessed sometime after its implementation. Likewise, the value of an innovation may also evolve over time and thus provide **different types of benefits to different stakeholders** (OECD, 2018).

Van Horne et al. (2010) comments that innovation value, whether perceived, created or captured, is **different for each actor in the value-based innovation process**. This is due to their different conclusions about the novelty and appropriateness of a new method, product or service depending on individual or organisational knowledge levels (or absorptive capacity) and context.

In the two sections that follow, we discuss the types of RDI frameworks: evaluation frameworks (2.5) and facilitation frameworks (2.6) as depicted in the figure below.

Figure 2.5: RDI frameworks discussed in this study

2.5 EVALUATION FRAMEWORKS FOR RDI

2.5.1 Introduction

Havas (2016) notes that: ''R&D is such a complex, multifaceted process that it cannot be sufficiently characterised by two or three indicators, and that applies to innovation a fortiori''. The selection of indicators is furthermore subjective and reflective of a particular of economic theory of innovation (Havas, 2016).

Havas (2016) distinguishes between the neo-classical school of economics and the evolutionary school of economics. In terms of the first, the focus is on optimising innovation through rational actions. The second school postulates that optimisation is impossible because of complexity of factors that influence the outcome of innovation and rather focuses on enabling knowledge creation and knowledge exploitation (in the positive sense of the word). In terms of this view, R&D is just one of the knowledge sources that impacts on innovation.

This view speaks to the evolution of innovation theory. Theories and models of innovation describe how uptake takes place in the adoption of innovations. These theories evolved from a linear ''diffusion of innovation'' (Rogers, 2003) to a systems approach (Spielman & Birner, 2008). Rogers (2003), which recognises the roles of interpersonal networks and change agents in the uptake/adoption of innovation, already leans toward a systems approach. The systems approach recognises that RDI uptake involves a complex web of related individuals and organisations (Spielman & Birner, 2008). Understanding and utilising knowledge networks is critical for research uptake/adoption of innovation (Spielman & Birner, 2008; Slabbert et al., 2019; Slabbert, 2017).

The level of RDI evaluations differ. Most technological innovation scores, indices or monetary values reflect the macro level (Havas, 2016). The values are calculated by aggregating micro level data (for example, economic indicators at the level of firms, or education indicators at the level of individuals). In contrast, social innovations can be monitored and observed at a project level, but, according to Havas (2016), it is difficult, if not impossible, to aggregate data at a macro level.

One can therefore expect differences between evaluation frameworks designed for the macro level (country or sector), frameworks design for the level of the firm, or the research organisation, and frameworks to evaluate RDI projects.

The Oslo Manual (OECD, 2015) distinguishes between the **reporting unit** (for example, private enterprises, or RDI projects) and the **statistical unit** (for example, sector, type of enterprise, country, etc.).

In the sub-sections that follow sets of indicators of RDI performance for each level (project level, RDI institutional level, and macro level) are discussed.

2.5.2 Evaluating RDI projects

Evaluations of RDI projects usually come in three forms:

1. Evaluations of the RDI proposal (also called ex ante evaluations) to select proposals for funding
2. Evaluations of the RDI project after completion (called ex post evaluations). These evaluations have the purpose to account for the investment, and include aspects such as:
    a. Meeting the aims and being on time and budget
    b. Producing an output of the expected or required quality
    c. Achieving the expected impact or delivering benefit/value
3. Learning evaluations (Spaapen et al., 2013) of research organisations or research programmes.

The first six subsections review literature on evaluation frameworks with the RDI project as reporting unit. The table below provides a summary.

Table 2.4: Evaluation frameworks with the RDI project as reporting unit

Framework	Key characteristics	Type of innovation
Payback framework	Focus on the ''story'' of the research in all its stages with non-linear feedback paths. The framework identifies two interfaces: the specification of the project and, secondly, the exchange of the knowledge.	All types
EIB i2i model	Evaluates the full life cycle of the project. Environmental and social impact are two of the six indicators	All types
Innovation Radar Survey (IRS)	Aimed at EU-funded projects; designed as an innovation management tool	Technological
Cost-benefit analysis (CBA)	Follows the EU guideline for CBA; attempts to monetize all benefits of RDI	Technological
JASPERS framework	Simplified version of CBA; focuses on direct project outputs only	Technological
SIAMPI framework	Measures social impact in terms of productive interactions. Aligned with innovation systems theory	Non-technological

2.5.2.1 Payback Framework

The Payback Framework was developed by Martin Buxton and Stephen Hanney by the Health Economics Research Group (Brunel University, UK) in the mid-1990s. Initially, the aim of the framework was to examine the impact or 'payback' of health services research (Donovan & Hanney, 2011). The Framework has since been further developed and expanded to other fields of research.

According to Donovan and Hanney (2011), the Framework "is a research tool used to facilitate data collection and cross-case analysis by providing a common structure and so ensuring cognate information is recorded". It consists of two elements:

- A logic model representation of the complete research process, and
- A set of five categories to classify different research paybacks (benefits).

Logic model of the complete research process

The figure below sets out the logic model.

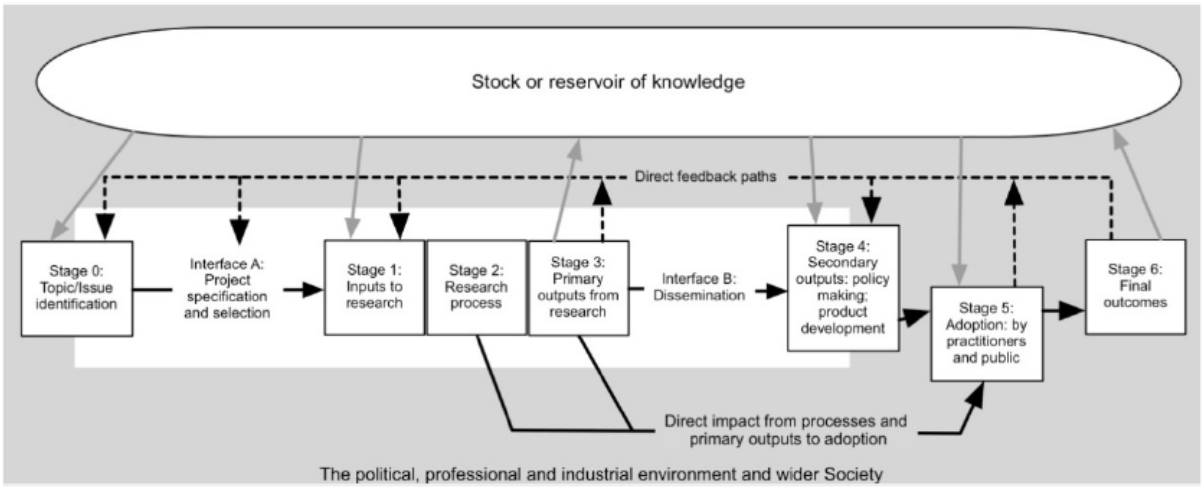


Figure 2.6: The logic model of the Payback Framework

The model consists of seven stages (Stages 0 to 6) as well as two interfaces (A and B) between the research system and the wider political, professional and economic environment.

The model represents the 'story' of research: "from initial inception (Stage 0) through the research process (Stage 2) into dissemination (Interface B) and on towards its impact on society, potentially reaching the final outcomes of health and economic benefits (Stage 6)" (Donovan & Hanney, 2011). In addition, the model contains numerous feedback loops which signals that the research process is not linear.

Five categories of research paybacks

The categories of research paybacks (benefits) are multi-dimensional as set out in table below. The first category is more traditional and focuses on the academic benefits of knowledge production and capacity building. The other categories focus on wider benefits for society.

Table 2.5: Multi-dimensional benefit categories of Payback Framework[10]

Benefit	Indicators
1. Knowledge	• Journal articles • Conference presentations • Books • Book chapters • Research reports

[10] Donovan and Hanney (2011) focus on benefits for the health sector. For the purpose of this study, the benefits were translated for the water sector.

Benefit	Indicators
2. Benefits to future research and research use	• Better targeting of future research • Development of research skills, personnel and overall research capacity • A critical capacity to absorb and utilise appropriately existing research including that from overseas • Staff development and educational benefits
3. Benefits from informing policy and product development	• Improved information bases for political and executive decisions • Development of products and techniques
4. Water sector benefits	• Improved water (resources and services) and sanitation • Cost reduction in delivery of existing services • Qualitative improvements in the process of delivery • Improved equity in service delivery
5. Broader economic benefits	• Wider economic benefits from commercial exploitation of innovations arising from R&D • Economic benefits from a population that has access to adequate and safe water and sanitation

According to Donovan and Hanney (2011), "it is not completely possible to tie the categories of benefits to specific stages of the model". However, in some cases there are strong correlations. The 'Knowledge' and 'Benefits to future research and research use' categories are often the primary outputs from research (Stage 3). The 'Benefits from informing policy and product development' category correlates with the secondary outputs (Stage 4). 'Water sector benefits' and 'Broader economic benefits' are generally final outcomes (Stage 6).

Use of the Payback Framework

The Framework has been widely applied in many countries. Kane (2019) for example applied the Framework to measure the impact of research at federal research organisations in the USA. Elema (2019) applied the Framework to the research of the Water Research Fund for Southern Africa (WARFSA).

Relevance for this study
The Payback Framework was particularly relevant because it had been widely applied in many countries and research fields, including water research in Southern Africa. It was furthermore relevant because it can be used for all types of water and sanitation research, and it considers indicators across the life cycle of a research project. .

2.5.2.2 The EIB i2i model

This model for ex-post (post implementation) evaluation of RDI projects was developed for selected projects in the fields of research, development and innovation under the Innovation 2000 Initiative (i2i) that the European Investment Bank (EIB) financed. The evaluation covered the period between the i2i launch in 2000 up to December 2006 (Dunnet et al., 2007).

Dunnet et al. (2007) comments that RDI projects ''have one key distinguishing feature; they are principally concerned with an increase in the stock of knowledge''. Since knowledge is intangible, the outputs of RDI projects are generally also intangible, making it difficult to evaluate them.

Dunnet et al. (2007) classified the sample of RDI projects that they evaluated according to sector, RDI stage, project budget size and promotor (private or public).

Projects were evaluated in terms of sustainability, efficiency, effectiveness, relevance, an overall score on all four criteria, and environmental and social impact. Below is a summary of the findings for the sample of RDI projects.

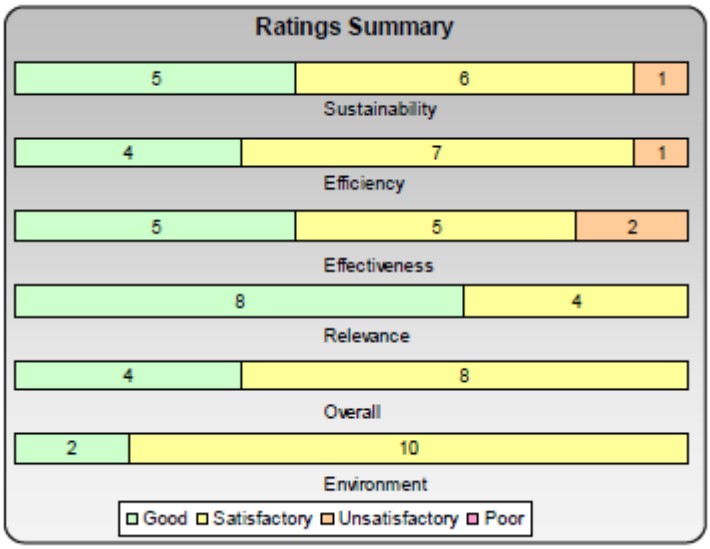


Figure 2.7: Summary of evaluation of a sample of RDI projects

The five criteria were further defined as follows (Dunnet et al., 2007)

Table 2.6: EIB i2i model criteria

Criteria		**Indicators**
Relevance		''The extent to which individual projects contributed towards achieving the policy objectives to which they were relevant''
Project performance	Effectiveness	The extent to which the project objectives have been achieved: deliverables on time, within budget, sound operational performance
	Efficiency	• For research projects: quality of research outputs as assessed by peer reviews and international comparison (publications?) • For development projects: recent financial performance and knowledge spillover (collaboration efforts) • For innovation projects: financial and economic rate of return
	Sustainability	''The probability that the resources will be sufficient to maintain the outcome achieved over the economic life-time of the projects, and that any risks can be managed'' Resources include

Criteria		Indicators
		management, track record, ability to mitigate risk, market position.
Environmental and social impact		Consequences on carbon emissions, energy efficiency, green spaces, involvement of local communities, transport, local employment, social cohesion, etc. where these are relevant.

The authors note that ''Most projects exhibited a mixture of elements, and the indicator chosen was therefore decided on a case-by-case basis'' (Dunnet et al., 2007).

Relevance for this study
We noted the comment that impact indicators might look different for different RDI projects. Although this study did not focus exclusively on output and impact, it was important in this study to link proposal reviews and post project evaluations and the possible correlation between them. The classification of RDI projects was useful and have already been referred to in section 2.3.

2.5.2.3 The Innovation Radar Survey (IRS)

The IRS measures the innovation potential and innovator capacities of EU-funded research projects. According to Nepelski and Van Roy (2020), the IRS is used as an ''intelligence platform'' to provide insights on innovation activities in large collaborative Research and Innovation (R&I) projects. The internal IRS tools allow evaluators to monitor R&I projects and custom support to facilitate the commercialisation of their results. The public IRS data platform can be used to find collaborative partners or investment opportunities.

The IRS evaluates both the innovation and the innovators. Because the IRS was conceived as an innovation management tool for EU-funded projects, indicators relate to the innovation process:

- Innovation readiness: Is the technology ready for commercialisation?
- Innovation management: Steps that the project consortium took or is taking to bring the innovation to the market including technology transfer, a business plan, or actions to secure investment from third parties
- Market potential: For example, Information or research on market size, market maturity, dynamics and the competition. These provide insights about the likelihood that the innovation can be successfully commercialised (Nepelski & Van Roy, 2020).

A survey is used to evaluate R&I projects. Below is an example of the questions asked.

(5) Level of innovation: What is the level of innovation?

(a) Some distinct, probably minor, improvements over existing products
(b) Innovative but could be difficult to convert customers
(c) Obviously innovative and easily appreciated advantages to customer
(d) Very innovative

(6) How will the innovation be exploited?

(a) Introduced as new to the market (commercial exploitation)
(b) Only deployed as new to the organisation/company (new internal processes implemented, etc.)
(c) No exploitation planned

(7) Indicate the step(s) in order to bring the innovation to (or closer to) the market

	Done or ongoing	Planned	Not Planned but needed/desirable	Not planned and not needed
1. Technology transfer				
2. A partner's research team and business units are both engaged in activities relating to this innovation				
3. Market study				
4. Prototyping in laboratory environment				

Figure 2.8: Example of questions on the IRS survey

Relevance for this study
The questions suggest indicators which could be useful for self-assessment of an RDI project, and they can be built into a plan to facilitate implementation and impact.

2.5.2.4 A cost-benefit analysis framework for RDI projects

In 2016, researchers from the University of Milan, published a working paper that summarises the main findings and lessons learned on how to apply cost-benefit analysis (CBA) for RDI projects[11]. In their view, ''the terrain is mostly unchartered'' (Florio et al., 2016).

Cost-benefit analyses is regarded as grounded in welfare economics (Florio et al., 2016). It is widely used to calculate the rate of return and the benefit/cost ratio of investments in, for example transport, water and energy, environment, education and culture (OECD, 2015). In essence, it expresses all inputs and outputs of a project in money at present value terms and then calculates a net effect on society (the net present value, or the internal rate of return, or a benefit/cost ratio).

[11] The publication is part of a research project "Cost/Benefit Analysis in the Research, Development and Innovation Sector". The Project Team is composed by the Departments of Economics, Management and Quantitative Methods (DEMM) and Physics of the University of Milan and the independent research centre CSIL. See team for more information. The project is financed by the European Investment Bank Institute (EIB Institute) in the frame of its EIB University Research Sponsorship Programme (EIBURS). http://www.eiburs.unimi.it/

However, it has not been applied to evaluate RDI projects, because of the ''intangible nature and the uncertainty associated to the achievement of research results'' (Florio et al. 2016:10).

Florio et al. (2016) follows the main aspects of a CBA as set out in the European Commission guideline document (European Commission, 2014). The paper distinguishes between user benefits and non-use benefits. Users could include scientists, students, benefitting firms or consumers. ''Non-use benefits'' refer to ''discovery as a public good'', i.e. the social value potential of the RDI, irrespective of whether it is yet actually used.

Costs include all project expenses. Since WRC projects are allocated a fixed amount that must cover all expenses, cost is simple and will not be further discussed. **However, the question whether funding is used optimally will be considered as a subcategory of Quality, a core stakeholder value.**

Florio et al. (2016) lists the following RDI project use benefits at a high level – use benefits are arranged according to beneficiary role:

Table 2.7: Use benefits of RDI projects

Beneficiary	**Use benefit**
Firms	New products, services and technologies
	Patents
	Start-ups created – expected profits
	Knowledge spill overs to businesses, professionals, organisations
	Learning by doing – through collaborations
Researchers and other human capital	Knowledge output products such as publications; increases in salary
	Students – qualifications
Consumers	Socio-economic benefits: Measured as Willingness to Pay[12] (WRP)and Willingness to Accept (WTA)
	Cost avoidance
	Cultural effects – also measured as WTP

Non-use benefits include:

- Discovery as a public good
- Future use benefits
- Tax payers' WTP to obtain a good or willingness to give up a good – tested by stated preference techniques such as the contingent valuation methodology.

Wider impacts such as the savings in travel time; increased life expectancy or quality of life; prevention of fatalities; injuries or accidents; improvement of landscape; noise reduction; increased

[12] European Commission, 2014: 59: The concept of marginal WTP is commonly used to estimate the shadow price of the project output. In other words, to evaluate the project direct benefits, related to the use of the goods or services rendered. The WTP measures the maximum amount of people who would be willing to pay for a given outcome that they view as desirable. Different techniques, including revealed preference, stated preference and benefit transfer methods, exist to empirically estimate the WTP. The adoption of one or another method depends on both the nature of the effect considered and the availability of data.

In absence of WTP estimates derived directly from users, or in the impossibility to adopt a benefit transfer, other proxies of WTP can be used. A commonly accepted practice is to calculate the avoided cost for users to consume the same good from an alternative source of production. For example, in the case of water supply projects, the avoided cost of water transported in tank lorries; in wastewater, the avoided cost of building and operating individual septic tanks; in energy, the avoided cost of substitute fuels (e.g. gas vs. coal) or alternative generation technologies (e.g. renewable energy sources vs. fossil fuels).

resilience to current and future climate change and reduced vulnerability and risk, etc. should also be considered in the calculation.

Whereas Florio et al. (2016) gives a high-level cost-benefit framework, the details of how the costs and benefits of an RDI project can be calculated are set out in the European Commission's Guide to Cost-Benefit Analysis of Investment Projects (European Commission, 2014).

In principle, it is possible to measure the economic performance of an RDI project once all cost and benefits have been quantified and valued in money terms.

The following indicators can be calculated (European Commission, 2014 65):

1. Economic Net Present Value: the difference between the discounted total social benefits and costs
2. Economic Rate of Return: the rate that produces a zero value for the Economic Net Present Value
3. Benefits/Costs ratio: the ratio between discounted economic benefits and costs.

Section 4.1 of the European Commission report discusses how the costs and benefits of water supply and sanitation projects can be quantified**.**

Lastly, the CBA includes a sensitivity analysis (that is, the factors that have potentially the biggest impact on the project) and a quality risk assessment (potential adverse effects and a risk matrix). The sensitivity analysis should show which variables are affected by adverse events (European Commission, 2014:69).

Our impression was that a cost-benefit analysis of individual WRC RDI projects would be complex, and that many benefit quantifications depend on the hypothetical WTP and WTA, which requires additional end-user research.

Relevance for this study
Despite the previous comment, one should consider attempts to calculate monetary benefits of especially technological innovations. The distinction that the model makes between beneficiary role and benefit should also be useful. Prof Stanley Liphadzi of the WRC commented the CBA would be relevant for certain types of WRC projects. A sensitivity analysis and quality risk assessment are potentially useful to include in an RDI project evaluation.

2.5.2.5 The JASPERS framework

Clarke et al. (2013) simplifies project-specific CBA for the JASPERS[13] programme with a set of direct outputs and benefits that are usually attributed to RDI projects.

The framework considers only:

- direct project outputs
- market values as indicative of the economic value that an output has for society. For example, the predicted financial revenue that the organisation or facility will receive for a license is regarded as indicative of its economic value.

[13] Joint Assistance to Support Projects in European Regions

- benefits delivered during the project period. Wider benefits beyond the project period are excluded.

Below is a list of the outputs and benefits that Clarke et al. has identified (2013:30) for an energy innovation:

Outputs	Short-term & Medium term benefit
Building Related Outputs	
Savings in energy use due to renovation of building.	Environmental and economic benefits linked to energy efficiency
Residual value of infrastructure	Benefit to society of residual value of investment
Job Related Outputs	
No. of jobs created for individuals over 35	Benefit to society of Creation of new jobs
Education Related Outputs	
No. of Masters graduates.	Benefit to society of educated labour force
Research Related Outputs	
No. of research contracts	Benefit to society of new knowledge creation and dissemination
No. of article in impacted journals	Benefit to society of new knowledge creation and dissemination
Commercialisation Related Outputs	
No. of spinouts	Benefits related to growth of company and knowledge transfer to the economy
No. patent granted	Benefit attributed to national registration of patent not captured by licensing, e.g. assignment of rights, competitive edge, improved market position
No. of Licence deals	Societal benefit attributed to commercial application of IP

Figure 2.9: Commonly associated outputs and benefits of RDI projects

Relevance for this study
The JASPERS study focuses on the evaluation of outputs. The listed indicators were useful and were considered as output indicators in this study

2.5.2.6 The SIAMPI framework

The SIAMPI[14] project followed a completely different and novel approach. It investigated evaluating the social impact of RDI projects. The concept of ''productive interactions'' is central to the analytical framework and is defined as:

> *the mechanisms through which research activities lead to a socially relevant application. An interaction entails a contact between a researcher and a stakeholder. The contact is mediated through various means, as diverse as a research publication, a policy report, a prototype, a guideline, a website, a design, a protocol, a membership of a committee, shared use of facilities or financial contributions by a stakeholder. We distinguish three main types of interaction:*
>
> - *direct or personal interaction,*
> - *indirect interaction through a medium,*
> - *financial or material exchanges* (Spaapen et al., 2013).

[14] Social Impact Assessment Methods through Productive Interactions

According to the SIAMPI approach, social impact is produced when productive interactions between stakeholders occur. An interaction is productive when it leads to efforts by stakeholders to apply research results to social goals, i.e. when it induces behavioural change. Interactions can be formal, or they can take place in informal networks.

The SIAMPI report includes a questionnaire, performance indicators and an impact mapping tool. Interviews and focus groups were used to assess the role of stakeholders. To assess the productivity of interactions, data was collected through interviews and quantitative methods.

The SIAMPI report emphasises that a network perspective is critical to understand how social impact is generated. This is similar to the innovation systems approach. The figure below illustrates the network perspective (Spaapen et al., 2013: 12).

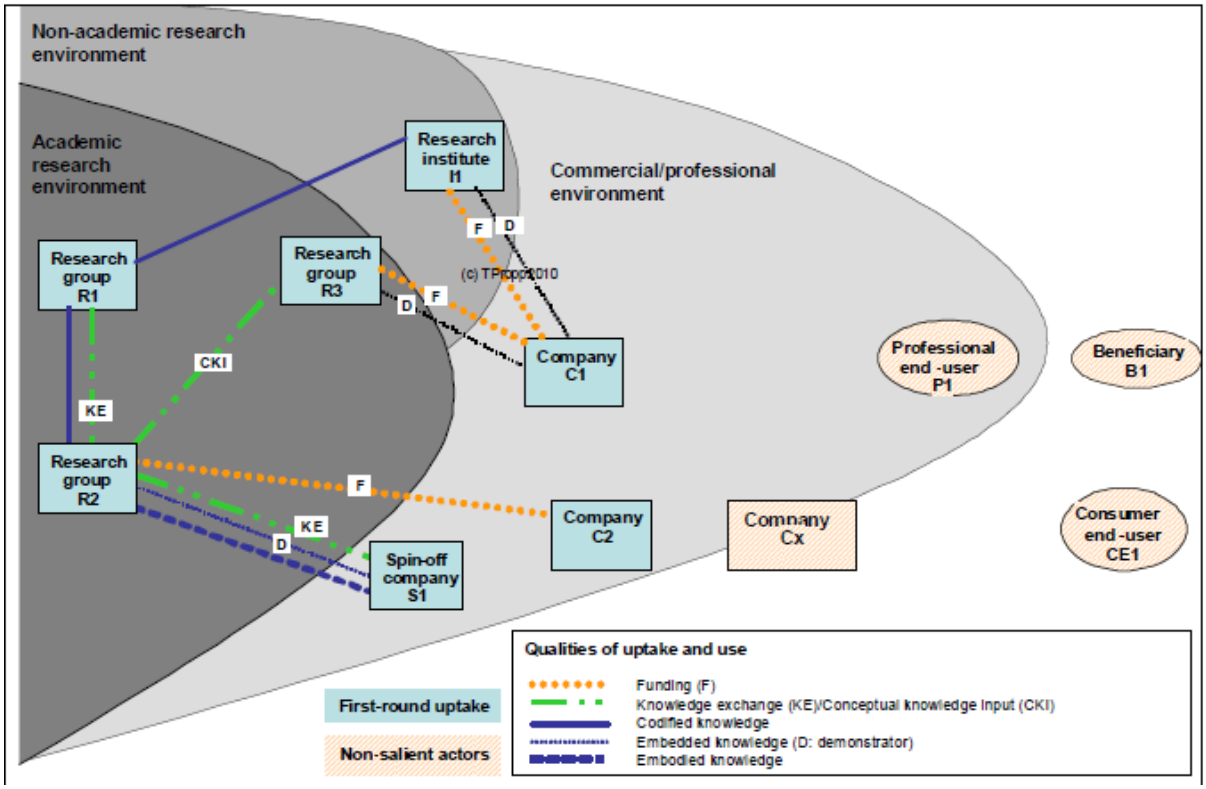


Figure 2.10: Downstream knowledge uptake in two case studies (SIAMPI report 2013)

Spaapen et al. (2013) notes that stakeholder interviews are useful to map actual impacts, but also to understand the dynamics behind impacts and the perspective of stakeholders on the value of RDI. Interviews with stakeholders beyond the definitive ones, could give guidance as to how networks could be broadened and strengthened.

Below are the discussion guide outlines for the researcher and beneficiary interviews (Spaapen et al., 2013: 25-26). The report is vague on how interview data has been analysed.

Researchers Interview	
1. Background/context questions	1.1 Information about the interview 1.2 Interviewee profile including - involvement in research project/programme, - main area of work; - activities carried out since project/programme.
2. Context	2.1 What actors have been the most important in determining the uptake/impact of your research? Could you mention some concrete examples? 2.2 What type of influence do they have? Is there a recognizable influence on the research agenda? Do they offer expertise useful for you? In what way? 2.3 Are there differences in the ways in which these actors may influence the uptake and impact of the results (including knowledge and skills) of your research?
3. Mechanisms of interaction	3.1 Direct interactions (personal) - regular contacts with practitioners in advance of the research assessed. - participation of stakeholders in design of project/ programme etc. - direct contacts with stakeholders within project/program/ period of assessment. - influence of these contacts on research work - development of these contacts within and after the project / programme 3.2 Indirect interactions (text & artefacts) - production of specified outputs: academic papers and articles; popular texts; grey literature and reports, web contexts, exhibitions, guidelines, standards, models, patents, etc…. - role of stakeholders in creating these outputs 3.3 Financial interactions - Involvement of stakeholders in the work being assessed, e.g. through contract funding or joined projects. - Kind of work being conducted under the formal agreement.
4. Outcome/Impacts	4.1 Do you, in any systematic or non-systematic way, follow the results of your research in society? 4.2 Have you applied in a non-academic context the knowledge or skills that you gained thanks to your participation in this project/organization? 4.3 Which stakeholders benefited and in what ways? - as a tool to solve stakeholder problems? - as the basis for ideas or arguments to justify, confirm or develop actions? - have they been used to design/develop services or articles for popular consumption? 4.4 If not, did you analyse why not?

Figure 2.11: Outline of discussion guide for researcher interview (SIAMPI report 2013)

Beneficiary Interview	
1. Background/context questions	1.1 Information about the interview 1.2 Interviewee profile - Type of link/involvement with the researcher/project/organization - Main area of work and position within the organization
2. Context	2.1 What other actors/stakeholders are the most important in determining the uptake/impact of the research results you are interested in? 2.2 What kind of contacts do you have with these other stakeholders and what type of influence do they have? 2.3 Are there differences in the ways in which the different stakeholders we have discussed may influence the uptake and impact of the outcomes of academic research?
3. Mechanisms of interaction	3.1 Direct interactions (personal) - regular contacts with research organisation and researchers in advance of the research assessed. - participation in design of research project/programme etc. - direct contacts with researchers within project/program/ period of assessment. - development of these contacts within and after the project / programme 3.2 Indirect interactions (text & artefacts) - knowledge of specified outputs before, during and after the project: academic papers and articles; popular texts; grey literature and reports, web contexts, exhibitions, guidelines, standards, models, patents, etc…. - participation in creating these outputs 3.3 Financial interactions - Involvement of stakeholders in the work being assessed, e.g. through contract funding or joined projects. - Kind of work being conducted under the formal agreement.
4. Outcome/Impacts	4.1 Did the relationships we have discussed in this conversation affect in any way the activities of your organization? If so, how? - Has knowledge of specified outputs (3.2) had any impact - Have any results been implemented in the organisation through new contractual relationships with the researchers 4.2 Who benefitted from the effects of the interaction and in what ways? - Did you use the research as a tool (or to develop tools) to solve problems you were facing? - Did you use research results as the basis for ideas or arguments to justify, confirm or develop actions? - Did you use the research to design/develop services or articles for popular consumption?

Figure 2.12: Outline of discussion guide for beneficiary interview (SIAMPI report 2013)

In addition, a three-step self-evaluation was developed to help research teams to report on social impact and to develop relevant indicators.

Step 1: Description of the research group's mission and objectives to have social impacts
The mission statement reflects the context of the research. It is a good idea to specify the societal domains and professional practices targeted by the research. For example:

- Training for skilled researchers and professionals in the field of X and/or for sectors Y and Z.
- Improvements to procedures in a particular profession.
- Production of knowledge for industry and the commercial sector, or conversion of knowledge into new economic activity.
- Production of knowledge for public sectors such as health care, education and culture.
- Production of knowledge to support the drafting, implementation and evaluation of policy.

The mission statement should also indicate how the research group intends to achieve the mission by, for example, specifying what type of research the group performs, whether it is involved in partnerships with stakeholders (and which ones), and what output it plans to produce.
Sometimes the mission statement will be more specific, including quantified objectives such as a particular number of professional publications, financial resources to be acquired, or contributions to education and training.

Step 2: Description of the societal contribution having realised in the period assessed.
Looking back over the period under review, it is possible to describe the actual societal contribution made by the research. The following four questions provide a useful guide:

- Question 1: What substantive results did the research yield that could be of importance to society?
- Question 2: How has the knowledge been disseminated among societal stakeholders?
- Question 3: What evidence is there of interest and appreciation on the part of societal stakeholders?
- Question 4: What effects have the research results had?

Although the impact of research is sometimes not felt immediately, it is nevertheless wise to identify any impact, or, in other words, any observable effect of your research. This might include adjustments of specific policies, use of a new therapy that reduces the burden of illness on patients, or income from patents or a successful spin-off.

Step 3: Compile a list based on indicators of societal relevance
In the third step, use indicators to compile a list of the research group's achievements in terms of societal relevance. Any specific results presented in step 2 can be aggregated by using indicators that are more generally applicable in your field or discipline.
The indicators reflect various aspects of societal relevance:

- the spread of research results,
- the degree of interest in and appreciation of the research among societal stakeholders,
- actual use of the research results.

Figure 2.13: The 3-step self-evaluation instrument to report on social impact (SIAMPI report 2013)

Spaapen et al. (2013) concludes that social impact indicators are context-dependent, which means that they can differ from one research project and discipline to another. They give an example of social impact indicators and productive interactions for an electrical engineering pilot project. See the figure below.

Aspect of social impact and productive interactions	Indicators
Dissemination of knowledge	PhDs in industry
	Master's graduates in industry
	Proofs of concept
	Presentations at specialist conferences
Interest of stakeholders	Joint road maps
	Presentations by invitation
	Knowledge exploitation grants
	Industry funding
	Staff exchanges
	Part-time professors from/in industry
	Consortiums with industry
Impact and use of results	Market launch and new products in industry
	Spin-offs with industry contacts
	Patents

Figure 2.14: Example of indicators of social impact and productive interactions (SIAMPI report 2013)

An interesting aspect of the SIAMPI initiative was the inclusion of Contextual Response Analysis, a methodology to trace internet usage of publications, press releases and any other online written material associated with an RDI project. The method uses one or more search engines and classifies the URL that refers to the publication or other types of output according to the domain or sub domain in which the user/URL operates. The results show the intensity of use and the origin of the users according to social domains, for example, Science or Healthcare.

This is similar to the Contextual Response Analysis that was conducted in the study (Slabbert, 2014) which analysed downloads and other user data of the WRC's key knowledge products.

Relevance for this study
The SIAMPI model has a number of aspects that was useful for this study: 1. Network perspective 2. Stakeholder mapping 3. Discussion guides 4. Self-assessment tool 5. Hierarchy of indicators of social impact 6. Contextual response analysis.

2.5.3 Evaluating RDI institutions

A publication of the European Commission (2017: 8-9) sets out evaluation indicators for RDI institutions. The indicators measure the total output and impact of RDI institutions.

- High quality of RDI outputs: bibliometrics, including altmetrics (Barnes, 2015); sufficient funding available; quality management system
- Collaboration between public RDI and government and the business sector: The example is given of the German Fraunhofer institute that gets 70% of its funding from contract work, either for government projects or for industry.
- Strong knowledge flows between science and business – awareness and uptake indices.
- Design and implementation of 'smart specialisation strategies' which focus resources on areas where there is potential for business absorption. Public research funding aimed at supporting the economy (making incentives available). Examples: In the Netherlands, partnerships between businesses, academia and public research centres and aims to increase the scope and ambition of business innovation.

- Cooperation with government to ensure an environment conducive for innovation: For example, the availability of venture capital, a supporting tax system, removing regulatory barriers, the availability of skilled labour, the efficiency of the public administration and the rule of law can all assist to create a supporting environment.

Relevance for this study
The indicators listed above are relevant for individual RDI projects and were considered in the RDI framework that was developed in this study.

2.5.4 Evaluating innovation at a macro level

2.5.4.1 The Oslo and Frascati Manuals

Van Beers et al. (2015:4) observes that several instruments have been developed over the past 20 to 30 years to, what they call, ''characterise technological innovations empirically through indicators''. The Oslo[15] and Frascati Manuals, both of which are endorsed by the OECD and the European Commission, are the internationally recognised methodology of collecting data on RDI activities. The Manuals comprise definitions of basic concepts, data collection guidelines, and classifications for compiling R&D statistics. The Frascati Manual focuses on R&D indicators, the Oslo Manual on innovation indicators, at country, sector, and enterprise level.

The OECD Frascati Manual (OECD, 2015), which was developed almost 60 years ago in the early 1960s, has become the global standard for collecting and reporting on the financial and human resources that are being used for research and experimental development (R&D). Today, the Frascati Manual forms part of a framework for science, technology, and innovation statistics, called the Frascati family of manuals, referred to as ''a body of guidelines in a state of constant and overlapping evolution'' (OECD, 2015:21). The Manual reports on the activities of R&D performers in four sectors: business enterprise (which includes public enterprises like the WRC), government, higher education, and private non-profit.

R&D activities are defined in the Manual as having new knowledge as an output. The purpose could be threefold: generating economic benefit, addressing societal challenges, or simply having new knowledge. Indicators focus on R&D funding (internal and external) and expenditure and details of R&D personnel.

The Manual acknowledges the complexities of measuring R&D outputs: ''Only very partial outputs can currently be directly identified and measured as part of collecting information on R&D activities and funding'' (OECD, 2015: 23).

The Oslo Manual focuses on technological and process innovation[16] at the business enterprise level, particularly manufacturing, construction, utilities, and marketed services. Surveys are used as the data collection method.

Indicators listed in the Oslo Manual (OECD, 2015) include:

[15] https://www.oecd.org/science/inno/2367614.pdf

[16] Definition: *A technological product innovation is the implementation/commercialisation of a product with improved performance characteristics such as to deliver objectively new or improved services to the consumer. A technological process innovation is the implementation/adoption of new or significantly improved production or delivery methods. It may involve changes in equipment, human resources, working methods or a combination of these*.

- Strategy: economic objectives; RDI and innovation strategy; use of advanced technology
- Diffusion of innovation; use of advanced technology; knowledge flows
- Factors assisting and hampering innovation: internal and external (e.g. public policy, funding; access to information)
- Inputs: budget and human resources (RDI expenditure; capital expenditure on advanced technology, advanced skills, R&D capabilities)
- Outputs: new and improved products and/or services; patents; cost reduction. For example: ''the impact of technological and process innovation can be measured by the percentage of sales derived from new or improved products'' (OECD, 2015).
- Literature-based evidence of innovations (as published).

Relevance for this study
The Frascati and Oslo Manuals were useful because they are the origin of basic definitions of R&D and RDI, and related terminology. The indicators of the Oslo Manual, although developed to be applicable at the enterprise level, was still useful at RDI project level.

2.5.4.2 The European Innovation Scoreboard

The European Innovation Scoreboard is another international innovation performance assessment. It provides a comparative analysis of innovation performance in European Union countries, with its main competitors.

As most of these macro level frameworks, it is biased towards technological innovation.

The indicator framework for the 2021 European Innovation Scoreboard is depicted below:

FRAMEWORK CONDITIONS (8 indicators)

- Human resources
  - * New doctorate graduates (STEM) (% share)
  - Population with tertiary education (% share)
- Attractive research systems
  - International scientific co-publications per million population
  - Top 10% most cited publications (% share)
  - Foreign doctorate students (% share)
- Digitalisation
  - Broadband penetration (% share)
  - * Individuals who have above basic overall digital skills (% share)

INVESTMENTS (8 indicators)

- Finance and support
  - R&D expenditures public sector (% of GDP)
  - Venture capital expenditures (% of GDP)
  - * Direct government funding and government tax support for business R&D
- Firm investments
  - R&D expenditures business sector (% of GDP)
  - Non-R&D innovation expenditures (% of turnover)
  - * Innovation expenditure per person employed
- Use of information technologies
  - Enterprises providing training to develop or upgrade ICT skills of their personnel (% share)
  - * Employed ICT specialists (% of total employment)

INNOVATION ACTIVITIES (8 indicators)

- Innovators
  - * SMEs with product innovations (% share)
  - * SMEs with business process innovations (% share)
- Linkages
  - Innovative SMEs collaborating with others (% share)
  - * Public-private co-publications per million population
  - * Job-to-job mobility of Human Resources in Science & Technology (% share)
- Intellectual assets
  - PCT patent applications per billion GDP (in PPS)
  - * Trademark applications per billion GDP (in PPS)
  - Design applications per billion GDP (in PPS)

IMPACTS (8 indicators)

- Employment impacts
  - Employment in knowledge-intensive activities (% share)
  - * Employment in innovative enterprises (% share)
- Sales impacts
  - Medium and high-tech product exports (% share)
  - Knowledge-intensive services exports (% share)
  - Sales of new or improved products ('product innovations') (% of turnover)
- Environmental sustainability
  - * Resource productivity (measured as domestic material consumption (DMC) in relation to GDP)
  - * Air emissions by fine particulate matter (PM2.5) in Industry
  - * Development of environment-related technologies

* New or revised indicator

Figure 2.15: Indicators of the European Innovation Scoreboard 2021 (European Commission, 2021a)

Relevance for this study
The European Innovation Scoreboard operates on a similar level as the OECD indices (Oslo and Frascati Manuals), i.e. the indicators are not directly relevant for the evaluation of RDI projects. However, it was still a useful framework to consider in the selection of indicators to evaluate the output and impact of RDI projects. Also interesting and relevant for this study, is the fact that, within this evaluation framework, qualifications at doctorate level in science, technology, engineering and mathematics and international publications are regarded as indicators of an environment that supports and attracts innovation.

2.5.4.3 The Global Innovation Index (GII)

With the recognition of social innovation, that is, organisational, managerial and behaviour innovations, the need for a different set of indicators arose. Havas (2016) gives an overview of the international indices of social innovation and the indicators that have been used. Only the Global

Innovation Index, an initiative of the World Intellectual Property Organization, will be discussed here.

The Global Innovation Index 2021 captures the innovation performance of 132 economies and tracks the most recent global innovation trends. It considers 20 indicators arranged under seven so-called pillars. The figure below depicts the pillars and indices used for the 2021 GII.

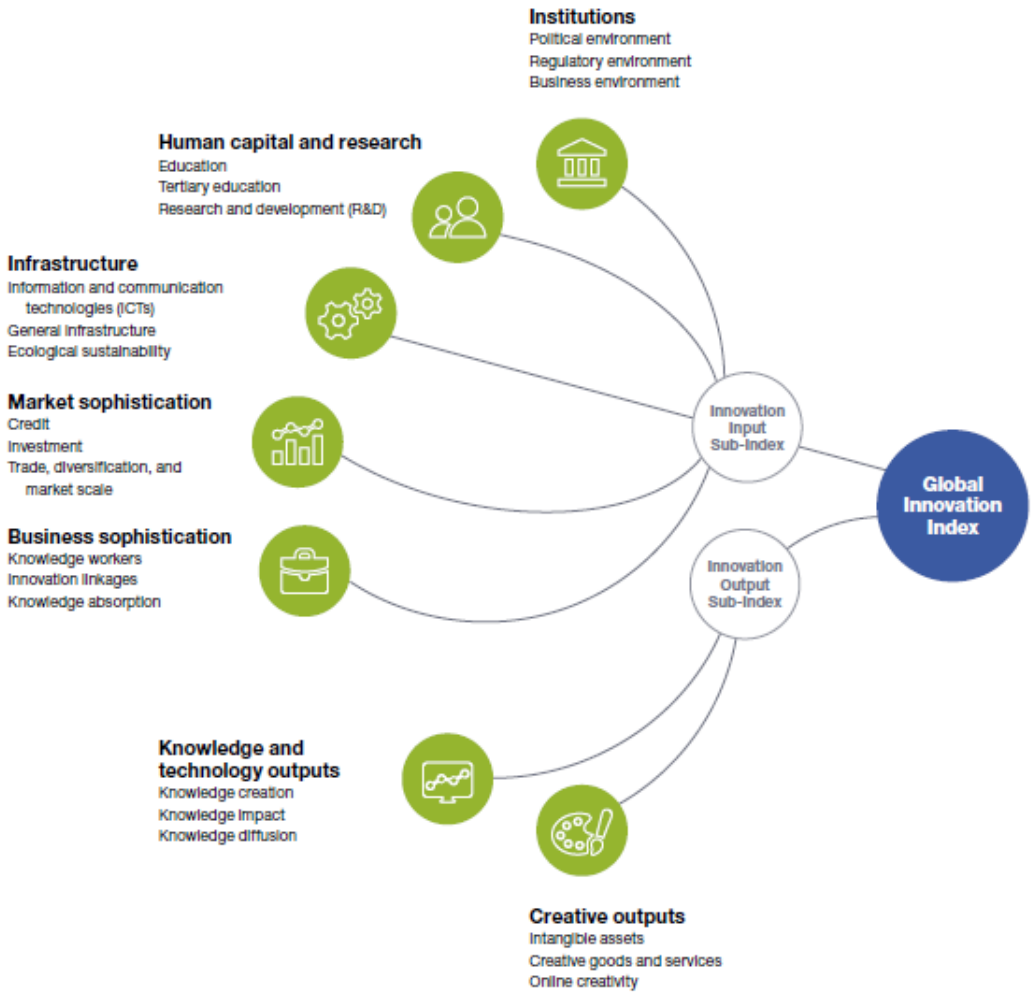


Figure 2.16: The Global Innovation Index 2021:39

The indicators of innovation outputs are the following for each of the two pillars:

Table 2.8: Global Innovation Index 2021: output indicators (Dutta et al., 2021)

Innovation outputs	Indicators	Sub-indicators
Knowledge and technology output	Creation of knowledge	Patent applications (National patents and number of Patent Cooperation Treaty applications) No of utility model applications Scientific and technical publications Citable documents (H-index)
	Knowledge impact	Increase in labour productivity (Growth rate of GDP per person employed) New firms per thousand population Spending on computer software (% of GDP) ISO 9001 certificates for Quality Management issued High-tech and medium-high-tech manufacturing (% of total manufacturing output)
	Knowledge diffusion	Fees for Intellectual Property (% of total trade) Production and export complexity (The Economic Complexity Index)) High-tech exports (% of total trade) Exports of communication, computer and information services (% of total trade)
Creative output	Intangible assets	Number of classes in resident trademark applications Global brand value of the top 5,000 brands Number of designs contained in resident industrial design applications Extent to which ICTs enable new organizational models
	Creative goods and services	Cultural and creative services exports (% of total trade) National feature films Global entertainment and media market (per thousand population) Printing and publishing outputs Creative goods export
	Online creativity	Generic and country code top level domains Monthly edits to Wikipedia Mobile App creation

The reporting unit is the individual organisation. For statistical purposes, data is aggregated to compare countries.

South Africa ranks 61st on the 2021 Global Innovation Index (GII), dropping one position from 2020. Its input ranking is 55th and its output ranking is 68th.

Relevance for this study
Although innovation input is not the focus of this study, the figure above was useful, because it highlights the factors that create an enabling environment for successful RDI output and impact. The study took note of the global indicators of innovation output and the output categories

2.6 FACILITATION FRAMEWORKS FOR RDI

Evaluating RDI projects, institutions and outputs for uptake and impact is one approach; facilitating RDI uptake and impact is another. In the literature, there are several examples of approaches and tools that are designed to strengthen or facilitate uptake and impact of RDI. Three examples are discussed in the sub-sections below.

2.6.1 An innovation systems approach

Extensive academic work in the field of agricultural innovation systems has led to valuable new approaches to RDI. The focus is not on the evaluation of RDI projects, but rather on supporting RDI projects with an innovation systems approach. Two examples from the literature are discussed here:

The Rapid Appraisal of Agricultural Innovation Systems (RAAIS) is strictly speaking not an evaluation framework. Schut et al. (2015) calls it a diagnostic tool that guides the implementation of innovative solutions to complex problems in agriculture (Schut et al., 2015). RAAIS can be used to shape and support RDI projects. Although developed for agricultural problems, RAAIS might be a useful tool to apply in other fields.

The tool analyses:

1. The problem in its different dimensions (for example, biophysical, technological, socio-cultural, institutional, political and economic, as relevant)
2. Interactions across national, regional and local levels and the interests and constraints of different stakeholders (knowledge networks)
3. The innovation capacity in the system:
    a. What are the constraints within the institutional, sectoral and technological subsystems?
    b. Is there an innovation support system and how well is it performing?

RAAIS combines qualitative and quantitative methods, and insider and outsider perspectives, to triangulate and validate data. The analysis aims to provide:

- Entry points for the specific innovation, and
- Recommendations as to how the innovation capacity and the innovation support system can be strengthened.

Innovation system facilitation is another concept that was developed within agricultural innovation system thinking (Klerkx et al., 2012). It emphasises the role of stakeholders who trade knowledge as a commodity, also called innovation brokers, or intermediaries, who bridge communication gaps between research, policy, and practice. Active innovation brokers would be a relevant indicator of the system's potential to innovate.

Relevance for this study
The use of a Rapid Innovation Appraisal process, and innovation facilitation, which includes mapping knowledge flows in the current active innovation system that an RDI project targets, is a proactive way to set up and support RDI projects to deliver value/benefits.

2.6.2 The UWA Research Impact Toolkit

The University of Western Australia's (UWA) Research Impact Toolkit[17] is designed to help individuals and organizations plan and develop an impact strategy for their research projects.

The Toolkit sets out a step-by-step approach to plan, monitor and improve the impact that a research project or programme will have on policy and practice:

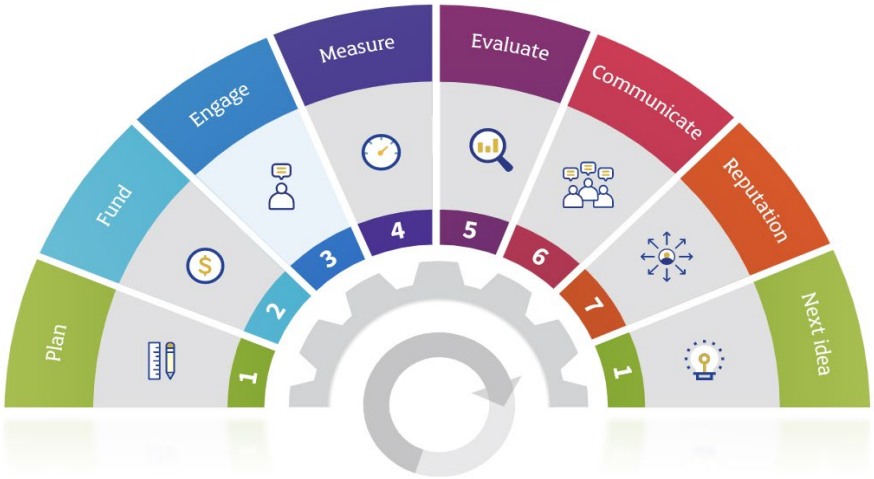


Figure 2.17: Step-by-step approach to plan for impact

The table below gives a summary of each step:

Table 2.9: Step-by-step approach to plan for impact

Plan	Identify potential impacts. Identify stakeholders, beneficiaries and end-users. Create impact pathway plan • Conduct stakeholder analysis • Formulate key messages • Write SMART impact goals • Make a plan.
Fund	Once funding is acquired, update and expand original proposal into a fully-fledged impact plan. This will help organise, implement and track engagement activities and impacts throughout the research process.
Engage	Develop a stakeholder communications strategy: who you want to reach, what you want to communicate; and how you want to reach them (channels and tools). Develop a process to capture evidence of engagement.
Measure	Identify areas of your research where data collection is possible. Should record information that: • give evidence of impact pathway • demonstrate the significance and reach of impact. Therefore, decide wat information is required, who will use this information, where it can be found and how often. Record as project is rolled out.

[17] https://www.rdi.uwa.edu.au/research-impact-toolkit#your-toolkit

Evaluate	Assess the progress of the impact indicators developed in Step 1 using a traffic light system. Plan next steps
Communicate and build Reputation	Present benefits of research findings Key objectives should be to: • maintain a positive connection with stakeholders • produce evidence of engagement and impact outside of academia • communicate impact • begin next cycle of engagement. Regular engagement including stakeholder collaborations will help to develop strong professional relationships and build reputation.
Next idea	Reflect on previous pathways to impact, determine what went well, how the impact plan can be improved and establish new ways to engage with stakeholders to build long-term, two-way and trusting relationships.

The UWA Research Impact Toolkit acknowledges that across and within the different disciplines and research sectors there will be considerable diversity in the types of impacts that can be achieved. The Toolkit therefore gives detailed definitions and examples of the different types of research impact that can be achieved. Below is a summary.

Table 2.10: Different types of research impact[18]

Type of impact	**Definition**
Understanding and awareness	People understand an issue better than they did before. Often lead (in time) to other types of impact.
Attitudinal	A change in attitudes, typically of a group of people who share similar views, towards a new attitude that brings them, or others benefits.
Economic	Monetary benefits arising from research, either in terms of money saved, costs avoided or increases in turnover, profit, funding or benefits to groups of people, or the environment measured in monetary terms.
Environmental	Benefits from research to genetic diversity, species or habitat conservation, and ecosystems, including the benefits that humans derive from a healthy environment.
Health and well-being	Research that leads to better outcomes for the health of individuals, social groups or public health, including saving lives and improving people's quality of life, and wider benefits for the well-being of individuals or social groups, including both physical and social aspects such as emotional, psychological and economic well-being, and measures of life satisfaction.
Policy	The contribution that research makes to new or amended laws, regulations or other policy mechanisms that enable them to meet a defined need or objective that delivers public benefit. Crucial to this definition is assessing the extent to which research made a contribution, recognising that it is likely to be one of many factors influencing policy.

[18] https://www.rdi.uwa.edu.au/research-impact-toolkit#table-of-impacts

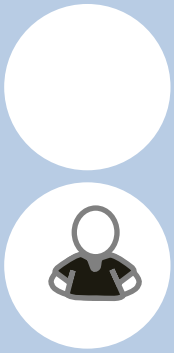
Type of impact	Definition
Other forms of decision-making and behaviour change impacts	Whether directly or indirectly (via changes in understanding/awareness and attitudes), research can inform a wide range of individual, group and organisational behaviours and decisions leading to impacts that go beyond the economy, environment, health and well-being or policy.
Cultural	Changes in the prevailing values, attitudes, beliefs, discourse and patterns of behaviour, whether explicit (e.g. codified in rules or law) or implicit (e.g. rules of thumb or accepted practices) in organisations, social groups or society that deliver benefits to the members of those groups or those they interact with.
Other social	Benefits to specific social groups or society not covered by other types of impact, including, for example, access to education or improvements in human rights.
Capacity or preparedness	Research that leads to new or enhanced capacity (physical, financial, natural, human resources or social capital and connectivity) that is likely to lead to future benefits, or that makes individuals, groups or organisations more prepared and better able to cope with changes that might otherwise impact negatively on them.

Relevance for this study
The list of the type of impacts was useful, especially because the Impact Toolkit recognises that not all types of RDI projects will have the same impact. The toolkit has a strong focus on stakeholder engagement and emphasises that stakeholder engagement is the golden thread that should run from inception until implementation and even beyond. Thirdly, the approach to integrate planning, monitoring and assessing impact across the full project cycle was another useful perspective for this study.

2.6.3 TAF and TIP

In 2011, the WASHTech consortium started a project to strengthen the uptake and impact of new WASH technologies (WASHTech, n.d.). The Technology Applicability Framework (TAF) was developed as a tool to assess how applicable, scalable and sustainable a specific new WASH technology is for a specific context to provide a sustainable service. Will it be taken up by the end-users and what is the probability that it will have sustainable impact? TAF can be used for planning and monitoring and also after implementation. The consortium also developed a tool to support the introduction of the new WASH technology, called the Technology Introduction Process (TIP). The two tools can be used together to ''identify the crucial links and interdependencies between technologies and investment models that are used to introduce these technologies'' (WASHTech, n.d.). At the time when the fact sheet was published, TAF and TIP have been applied in Ghana, Burkina Faso, Uganda, Nicaragua and Tanzania (a total of 20 times).

The tool comprises 18 indicators in 6 areas. For each area, there are three indicators, representative of the perspective of the three key actors: user/buyer; producer/provider; and regulator/investor/facilitator. For each indicator. There are 2-6 questions that the key actors have to answer (a total of 57 questions). Below is an example of an indicator sheet:



Social	
1 – Demand for the technology	
User, buyer	

Why is this indicator relevant?

Target users must express a real need or demand for the services provided by a technology if management challenges are going to be overcome in the future. Cultural taboos can cause users to reject a technology. If users feel a technology is inferior, they may reject it. If users are unwilling to invest in a technology or pay for its operation and maintenance, prospects for sustainability will be undermined.

Scenario: Water – Existing – General

GQ	Guiding Question	Explanation
GQ 1.1	Do the majority of users express a strong demand for the improved service level provided by this technology? What alternatives would there be?	Strongly expressed demand is vital to get good prospects for sustainability.
GQ 1.2	Will this technology genuinely satisfy the demands and expectations of the majority of target users? Are there many people/groups not benefiting?	The likelihood of a technology being sustainable will only be good if it genuinely meets the needs and expectations of target users.
GQ 1.3	Do all users in the target region accept this technology with respect to taboos, cultural, social and religious habits and traditions? What would be possible barriers or conflict areas?	Cultural and social acceptance is essential for sustainable uptake. If a technology is viewed as inferior for any reason, it may not be accepted.
GQ 1.4	Which groups within the population cannot use /are excluded from using this technology, for example disabled persons, the elderly or the very poor?	Inclusive, equitable service levels should be a high priority.
GQ 1.5	Do potential users express their willingness to invest in the CapEx of this technology and its introduction? Have they contributed to the CapEx of any other water service before? If not, why would they be willing this time?	The full capital cost of this technology and its introduction needs to be worked out BEFORE putting this question to users, so that an informed discussion can take place!
GQ 1.6	Are users willing to carry out regular upkeep activities and to pay for O&M (OpEx) on a regular basis? Are they willing to pay for major rehabilitation (CapManEx) if the water service breaks down? Have they contributed to OpEx or CapManEx before? If not, why will they be willing this time?	The full O&M cost of this technology, as well as the cost of major rehabilitation, needs to be worked out BEFORE putting this question to users so that an informed discussion can take place!
Scoring Question SQ 1	Is there a strong demand from target users for the services provided by this water technology AND a willingness to pay for CapEx, OpEx and CapManEx?	Score for indicator 1

Figure 2.18: TAF scoring sheet (WASHTech, 2013)

The data for the assessment is collected through a desk study of secondary data and focus groups with key stakeholders, plus limited household surveys during field visits.

The indicators are scored in the focus groups, which involve all the key actors. Key actors answer the questions on a scale of 3 (negative, neutral, positive). Answers are aggregated qualitatively, and the score for each indicator is presented as a traffic light (green = positive, yellow = neutral or partial impact, red = critical/alert). If the group disagrees, or the basis of the scoring is not clear, the score is a black icon and a question mark. See the example on the right. Key perspectives refer to the indicator score for each of the key actors. The six icons represent the six areas.

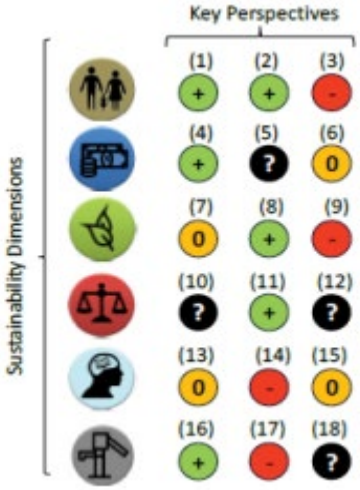


Figure 2.19: TAF scores (WASHTech, n.d.)

According to WASHTech (n.d.), TAF identifies if there are issues with the specific technology and also if there are issues related to the enabling environment. The TIP gives guidance on the how the technology should be introduced.

TAF and TIP was introduced in Ghana, Burkina Faso, and Uganda in cooperation with the national ministries through a Memorandum of Understanding (MoU).

Relevance for this study
TAF and TIP's strong focus on stakeholder networks and sustainability was particularly useful for this study.

2.7 METRICS

2.7.1 Defining the term

A metric is defined as ''a meaningful measurement taken over a period of time that communicates vital information about a process or activity, leading to fact-based decisions''.[19] According to the source, a good metric has the following characteristics:

- Drives appropriate action
- Meaningful to users
- Simple, understandable, logical and repeatable
- Clearly defined
- Generates data that is economical to collect
- Shows how organisational goals and objectives are being met.

Performance metrics are widely used to assess, compare and track the performance of organisations and individuals in terms of effectiveness, efficiency, improvement and best practice. Performance metrics are often called ''Key Performance Indicators'' or KPIs.

[19] Association Forum. 2013. Performance measurement and metrics. [Online] Available from: https://www.associationforum.org/mainsite/browse/professional-practice-statements/performance-measurement-metrics.

2.7.2 Quantitative and qualitative metrics

Metrics to measure the value indicators of water and sanitation RDI are quantitative or qualitative. Most quantitative metrics involve counting different RDI outputs, such as bibliometrics and altmetrics, or quantifying RDI impact, such as the number of jobs created. Qualitative metrics include Likert scales used, for example, in peer reviews of the scientific rigour of an RDI project's methodology, or the potential solution that a project offers to the water sector.

Peer reviews have been criticised in the literature (Maubassin, 2012) as subjective and depending on the perspective of the stakeholder and the specific nature of the RDI project or programme. For this reason, the metrics that this study has developed combine qualitative and quantitative metrics.

2.8 THE WATER RESEARCH COMMISSION

2.8.1 Introduction

This section outlines the institutional RDI framework of South Africa's primary water research institution, the Water Research Commission of South Africa (WRC), and the research that it has done previously to monitor and evaluate the uptake of its research.

2.8.2 Vision and mission

The vision and mission statements of the WRC capture the organisation's commitment to deliver value to its stakeholders through high quality and relevant research:

Figure 2.20: Vision and mission of the WRC (2018:2)

2.8.3 The quest for impact

In its Corporate Plan for the fiscal years 2015/16-2019/20 (WRC, 2015), the WRC states that it aims to achieve maximum research impact. **From the WRC's perspective, it seems therefore that impact equates RDI value**. Impact is unpacked as socioeconomic and/or academic:

- Socioeconomic impact: *the demonstrable contribution that excellent research makes to society and the economy, of benefit to individuals, organisations and the nation.*
- Academic impact*: the contribution that excellent research makes to advances across and within disciplines, including significant advances in understanding, method, theory, and application.*

The impact of research can furthermore be:

  - instrumental (by influencing policy development, practice or service provision, shaping legislation, altering behaviour),
  - conceptual (contributing to the understanding of policy issues, reframing debates), or
  - capacity building (through personal or organisational skill development*).* (WRC, 2015:2).

The WRC identifies the following aspects as vital for generating impact (WRC, 2015:43):

- *Excellent leadership and research management support*
- *Portfolios of research activity that build good reputations with research users*
- *Established partnerships with research users and other stakeholders*
- *Involving potential users at all stages of the research, including working with user groups*
- *Well-planned public engagement and knowledge exchange platforms, including the use of product strategies which tailor communication products to the needs of users*
- *Understanding and targeting barriers to and enablers of uptake.*

The WRC (2015:44-45) admits that evaluating the impact of research is not a straightforward nor linear process. *The only way to answer the question, 'were our activities successful?' is to build in impact assessment from the beginning of each project. Effective assessment is about improvement. It offers an opportunity to demonstrate how well the interventions worked but also to identify areas that need to be improved. It should also explore the entire portfolio – from the early planning stages through to final delivery.*

This quote became a key guiding principle of the stakeholder value framework developed in this study.

The WRC's latest Corporate Plan for 2018/19-2022/23 (WRC, 2018) confirms the above categories of impact. The Plan emphasises that impact must be demonstrable:

> *It is not enough just to focus on activities and outputs that promote research impact, such as organising a conference or publishing a report. We must be able to provide evidence of research impact. (WRC, 2018:59).*

The Plan prioritises quality: **without quality research, there can be no impact** (WRC, 2018:59).

The WRC recognises in its latest Corporate Plan that the organisation should **plan for impact** by engaging stakeholders to:

- *Identify our key partners and stakeholders, for example, other researchers, public sector, business/industry*
- *Identify how they will benefit from our research – types of impact might include: improving social welfare and/ or public services, influencing policy, contributing to industrial competitiveness*
- *Identify how we will ensure they have the opportunity to benefit, for example, through organising public events, conferences, interaction with the media, sharing of intellectual property*
- *Creating platforms to receive stakeholder concerns and needs that can determine research questions. (WRC, 2018:59-60).*

From the above, we deducted the following indicators of uptake and impact, in other words RDI value, to apply at the different project stages:

At the input stage:

- Leadership
- Stakeholder engagement
- Research management support

At the project rollout or process stage:

- Involving potential users at all stages of the research, including working with user groups
- Well-planned public engagement and knowledge exchange platforms, including the use of product strategies which tailor communication products to the needs of users
- Understanding and targeting barriers to and enablers of uptake.
- Built-in impact assessment

At the project outcome stage:

- For socioeconomic impact: demonstrated benefit to society, individuals, the economy, organisations, and South Africa
- For academic impact: demonstrated advances in understanding, method, theory, or research application in a particular discipline (or across disciplines)
- Demonstrated instrumental or conceptual impact, and/or capacity building.

It is interesting that the National Research Foundation's ''Draft Framework to Advance the Societal and Knowledge Impact of Research'' (NRF, 2021) echoes the WRC's approach. The NRF framework seeks to advance the impact of research, which it defines as ''a *beneficial change in society or knowledge advancement''.* It distinguishes between knowledge impact and societal impact and identifies four, so-called ''pathways'' to impact: inputs, activities, outputs, and outcomes. **Outcomes refer to the application or use of outputs, in other words, the uptake of the outputs.**

The NRF concedes that the organisation cannot control impact, but it can ensure that research impact is considered right from proposal development until the final research outputs**. Engaged, collaborative and inclusive research processes are regarded as advancing impact**. The NRF's intention with its draft framework is to identify and communicate research impact, rather than to compare, evaluate, or measure impact.

2.8.4 The WRC's internal performance indicators

The WRC's performance indicators for the period 2018/19-2022/23 are set out in the tables from the Corporate Plan (WRC, 2018) below:

Table 2.11: The WRC's internal performance indicators

1. Impact Portfolio

Objective	Indicator	Target for 2017/18	Target for 2018/19	Target for 2019/20	Target for 2021/22	Target for 2022/23
Strategic Goal: To develop innovative products and services for economic growth						
To capitalise on projects that develop intellectual property or to introduce innovations which create new or improved technologies, products and services used in the economy	The number of innovations, products and services that have been supported and/or implemented/ demonstrated / piloted.	New indicator	12	16	17	18
Strategic Goal: To drive sustainable development solutions						
To ensure that the WRC increasingly drives sustainable solutions for the Water Sector by hosting events that promote robust engagement around critical emerging water management issues	The number of WRC Dialogues	18	18	20	22	24
To promote the uptake and application of sustainable solutions by the water sector through broader engagements	The number of conferences/summits with the WRC as a host	New Indicator	2	3	2	3
Strategic Goal: To inform policy and decision making						
To influence policy- and decision-makers with research-based knowledge	The number of policy briefs produced and distributed to relevant government departments and other entities	14	12	13	13	13
	The number of ministerial briefs produced by the WRC and received by the Minister's Office	14	14	15	15	15
	The number of working papers produced that support decision-makers with research-based knowledge	New indicator	6	8	10	10
	The number of Parliamentary briefs produced and disseminated	New indicator	8	8	9	10

2. Partnerships

Objective	Indicator	Target for 2017/18	Target for 2018/19	Target for 2019/20	Target for 2021/22	Target for 2022/23
Strategic Goal: To promote transformation and redress						
To enhance the profile of project partnership as part of the national transformation project to promote the ongoing transformation of water research and development	To develop an inclusive strategy assists the tertiary institutions to add value to their activities in the water domain	New indicator	Approved strategy by Executive in Q4	n/a	n/a	n/a
To better enable researchers to participate in WRC funding instruments and specialised contracts	The number of WRC 101 workshops held in the financial year	New indicator	6	6	6	6
Strategic Goal: To develop innovative products and services for economic growth						
To ensure that the WRC invests in projects that results in the multiplier effect by partnering with strategic traditional and non-traditional partners to complement the WRC's mandate on either side of the value chain for water sector and societal impact	The number of workshops held in partnerships with other institutions	New indicator	20	22	22	22
	The number of partnership agreements signed with partnering institutions	New indicator	4	5	6	6

3. Research, Development and Innovation Portfolio

Objective	Indicator	Target for 2017/18	Target for 2018/19	Target for 2019/20	Target for 2021/22	Target for 2022/23
Strategic Goal: To enhance knowledge across the water knowledge and innovation cycle						
To enhance knowledge through new research RDI projects initiated	The number of new research projects initiated in the 2018/19 financial year	80	80	90	90	90
To maintain a portfolio of RDI projects that enhances water knowledge and the innovation cycle	The total number of RDI projects managed by the WRC	New indicator	250	350	350	350
To complete and finalise RDI projects scheduled in the financial year	The number of research projects that have been completed in the financial year	84	80	84	85	85
Strategic Goal: To enhance knowledge across the water knowledge and innovation cycle						
Growing a more inclusive water and sanitation science community of practice	The total number of project leaders on WRC managed projects that are female	New indicator	80 (32%)	85	85	90
	The total number of projects leaders on initiated projects that are female	New indicator	26 (33%)	26	27	28
	The total number of project leaders on WRC managed projects that are black and male	New indicator	85 (34%)	85	87	90
	The total number of project leaders on initiated projects that are black males	New indicator	20 (25%)	25	30	30
	The total number of female and black project leaders on initiated projects	New indicator	50 (63%)	55	65	60
	The total number of project leaders on initiated projects that are female and black	New indicator	120 (148%)	120	125	130

Objective	Indicator	Target for 2017/18	Target for 2018/19	Target for 2019/20	Target for 2021/22	Target for 2022/23
	• The number of students supported on all WRC managed research projects. • Distributed as follows: - Postdocs, PHDs & Masters - Honours and others	300 210 (70%) 90 (30%)	300 210 80	300 210 70	200 210 70	310 215 70
Strategic Goal: To develop innovative products and services for economic growth						
To increase the number of new innovations/products and services produced from WRC research	The number of innovations/products and services produced from WRC research	23	24	24	24	24

4. Financial Portfolio

Objective	Indicator	Target for 2017/18	Target for 2018/19	Target for 2019/20	Target for 2021/22	Target for 2022/23
Strategic Goal: To maintain financial and income sustainability						
To maintain income financial sustainability	The total amount of leverage income	R71 697 923	R78 251 637	R82 711 981	R87 426 564	R98 210 906
	Initiate contracts with other organisation's that increase leverage funding	4	4	5	6	6
To diversify the income streams of the WRC	Development of Diversification Income Strategy to maintain financial sustainability	New indicator	Approved strategy	n/a	n/a	n/a
To improve the response to internal audit results	The percentage of the internal audit findings fully addressed	100% of findings resolved	100% of findings resolved	100% of findings resolved	100% of findings resolved	100% of findings resolved
To improve the response to the external audit results	The achievement of an unqualified audit report vs a qualified audit report	Unqualified audit report to be achieved	Unqualified audit report to be achieved	Unqualified audit report to be achieved	Unqualified audit report to be achieved	Unqualified audit report to be achieved
	The percentage of external audit findings fully addressed	100% of audit findings resolved	100% of audit findings resolved	100% of audit findings resolved	100% of audit findings resolved	100% of audit findings resolved

5. Human Resources and Corporate Wellbeing Portfolio

Objective	Indicator	Target for 2017/18	Target for 2018/19	Target for 2019/20	Target for 2021/22	Target for 2022/23
Strategic Goal: To enhance social responsibility and corporate responsibility						
To ensure social and corporate responsibility	The total number of active research and non-research community based projects	New indicator	106	108	108	108
	The total number of initiated community-based research projects	24	27	28	28	28
	The total number of SMMEs supported on WRC managed research projects	New indicator	120	68	68	68
	The total number of SMMEs supported on WRC managed initiated research projects	27	20	22	22	22
To promote transformation and redress and cultivate a high performance organisational culture	To increase employee engagement by conducting surveys that establishes the gap between current reality (what employees are experiencing) and the vision (what organisational culture employees want to experience)	New indicator	Current reality and vision surveys com-pleted	n/a	n/a	n/a
	• To maintain or increase the percentage of black, female and employees with a disability at the WRC • Measured by - The total number of black number of employees -The total number of female employees - The total number of employees with a disability	New indicator	86% 58% 1.32%	6% 58% 1.32%	86% 58% 5%	86% 58% 5%
To develop strategies to support business leadership of the organisation	Develop an IT governance strategy	New indicator	Annual target	n/a	n/a	n/a
	Implement a leadership and organisational development strategy	New indicator	Annual target	n/a	n/a	n/a
	Maintain number of staff with Masters	New indicator	20	26	26	26
	Main number of staff with PhDs	New indicator	14	16	16	16
	The total number of employees in receipt of a study grant for the financial year	New indicator	7	10	10	10
	The total number of training courses held in-house	10	15	20	20	20
	The total number of external training courses attended	25	15	20	20	20

The indicators focus on output numbers, for example the number of projects and the numbers of knowledge exchange briefs, documents, and workshops. The indicators also have a strong focus on transformation, redress, and inclusivity.

The WRC's APPs do not reflect the strong emphasis on demonstrable impact and research quality indicators that was found in the literature review.

2.8.5 Overview of WRC's research to evaluate uptake and impact

Over the years, the WRC has undertaken several research studies to investigate:

1. stakeholder's perceptions and use of the organisation's research products, and
2. uptake and impact of research-based knowledge in selected fields.

Most of the studies made a several recommendations as to how uptake and impact can be improved.

Van Ryneveld, M., & Sproule, S. 2007. WRC Report No. 1519/1/07

In 2007, the WRC published a study by Van Ryneveld and Sproule on a methodology to assess knowledge uptake by professional technicians and decision makers for developmental water services. The study found a correlation between knowledge uptake and competency levels. No recommendations were made as to how knowledge uptake could be improved.

Slabbert, S & Van den Berg, I. 2010. WRC Report No. K8-939 and 940

In 2010, the WRC commissioned CRC to conduct stakeholder research as part of Consultancy Projects K8-939 and 940: Towards a communication strategy for the Water Research Commission. The objectives of the research were to:

- Define to what extent the various stakeholder groups of water research evaluate the current and past WRC research as achieving the WRC's objectives; and
- Define, from the perspective of various stakeholder groups, the role of water research in South Africa in future.

The research entailed 104 individual qualitative interviews, and an e-mail survey with 358 respondents (462 respondents in total).

The interviews investigated if stakeholders perceive the WRC's research as visionary, relevant, independent, trustworthy, solution-driven, and useable. Usability was unpacked according to the descriptions in the WRC's *Abridged Knowledge Review 2008/2009*:

- *Valuable to inform decision-making processes*
- *Improving monitoring and assessment tools*
- *Making available new and improved technology relating to water resource management and the provision of water and sanitation service"*
- *Supporting the development of adaptive and mitigating strategies to ensure the future sustainability of the country's water resources and services.*

In general, stakeholders were positive about the WRC achieving its objectives. However, for all the statements, it was clear from the number of ''don't know'' responses that respondents were not well-informed of the WRC's work. They were also less positive about WRC research providing solutions for their water problems and the implementation (uptake) of research findings.

The study concluded that involving representatives of the intended beneficiaries as research partners increases the probability that the intended beneficiaries will be:

a. Aware of the WRC, its mandate and its products
b. Understand the solution that the research offers, and
c. Use the knowledge to their benefit.

Slabbert, S. 2014. Stakeholder survey (not published)

In 2014, the WRC commissioned a stakeholder survey to test perceptions, the accessibility and usability of four of its knowledge products, research reports, Water Wheel, Water SA and Knowledge Reviews (Slabbert, 2014).

For each product, the sample included users, weak users and non-users.

- A user was defined as a stakeholder who is aware of a product and who regularly reads or uses it.
- A weak user was defined as a WRC stakeholder who is aware of a product, but who seldom uses it.
- A non-user was defined as a stakeholder who either is not aware of a product or someone who might be aware of a product, but who has never seen or read it.

Stakeholders responded to the survey as follows:

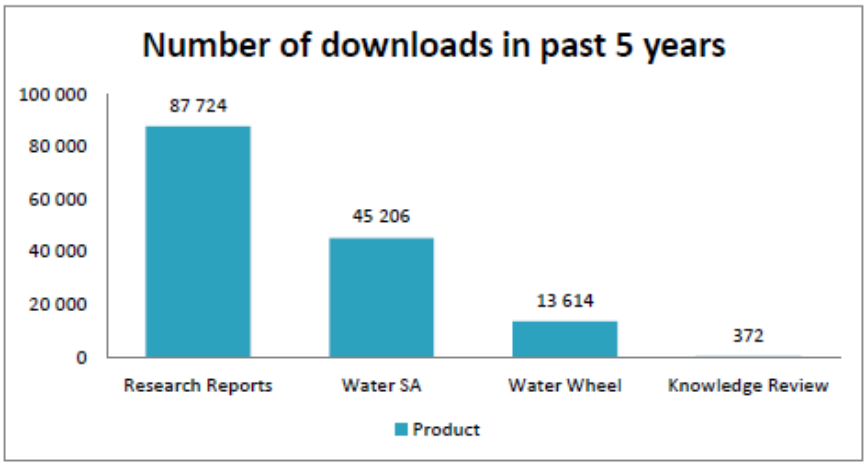
- Research Reports (217 responses)
- Water Wheel (304 responses). This number includes 66 hard copy responses.
- Water SA (181 responses)
- Knowledge Review (116 responses).

The survey questionnaire asked if stakeholders:

- Know the product and associate the product with the WRC
- Perceive the product positively: high quality, informative, beautiful photography, etc.
- Access the product with ease
- Find what they need in the product
- Find the format and content easy to follow
- Use the information for their specific purpose
- Share the information with other stakeholders.

In addition, the download data of each of the knowledge products were analysed. For Water Wheel, subscriptions were also analysed. In 2014, the WRC website statistics was probably the most accurate indicator of the use of a knowledge product. (It was noted in the report that 8000 hard copies of Water Wheel were distributed to subscribers. Water SA can also be downloaded from the AJOL, SciELO and Sabinet websites.)

According to the WRC's download data, the four products had the following number of downloads over the previous 5 years:



66% of the downloads of WRC Research Reports comprised academics and consultants. The Department of Water and Sanitation and municipalities did not feature among the top five online user groups.

All four the products received excellent quality assessments from users. WRC products also compare very well with other research reports or journals.

The survey found that the main reasons why a product is not read regularly are:

- It is slow or cumbersome to download (all four products)
- Not very useful (Research Reports)
- Other sources are more useful (Research Reports, Water Wheel and Water SA)
- Don't always have the time to read (Water Wheel).

The finding that 65% of users of Research Reports have been involved in reports as author, Reference Group member, reviewer or Project Team member is particularly relevant for uptake and impact.

Answers to the open question "Please tell us how you have used a specific Research Report in your work" gave fascinating insights into how stakeholders have applied WRC research.

The study recommended the following:

1. The WRC should target stakeholders in the Department and local government individually to bring relevant information to their attention. Many respondents across all four products requested targeted communication in the form of an email alert with a relevant web link or an attached PDF file.
2. Although respondents were generally positive about the accessibility of products, there is sufficient evidence that the WRC's search engine, its accuracy and speed can be improved. Several respondents mentioned the importance for the WRC to keep abreast of the latest IT developments so that the organisation can continuously improve its service to stakeholders. It was recommended that the WRC invest in a project to improve the 'discoverability' of its website content by Google and Google Scholar.
3. The download statistics of the WRC needs to be cleaned up and the process to generate these statistics needs to be revisited. The lists of top users mix internal and external users; contain many duplicates and the user categories overlap. The number of 'Other' users is unacceptably high.
4. The WRC should follow up on the many useful suggestions that stakeholders made.

Slabbert, S. 2016. WRC Report No. 2476/1/16.

In 2016, the WRC commissioned a study to investigate how its research products rate in terms of awareness, uptake and impact in the municipal environment and hence the contribution that these products make to sustainable wastewater and sanitation services.

The study aimed to:

- Give the WRC insight into the factors that shape the use of research-based knowledge in the municipal environment
- Give the WRC insight into the uptake and impact of its research products in wastewater and sanitation services, and
- Identify success stories and map opportunities.

The primary research comprised qualitative interviews with **108 municipal officials working in wastewater and sanitation services and 70 self-completed questionnaires.** The purposeful sample

of 22 municipalities represented all nine provinces and included six Metros, seven B1, four B2, four B3 and one C2 municipality.

A tool was developed to analyse the correlation/interaction between municipalities' performance journey and the way that they engage with knowledge in terms of knowledge needs, knowledge gaps, knowledge sources and knowledge use. The study confirmed a correlation between performance and engagement with research-based knowledge as represented in the performance roadmap below:

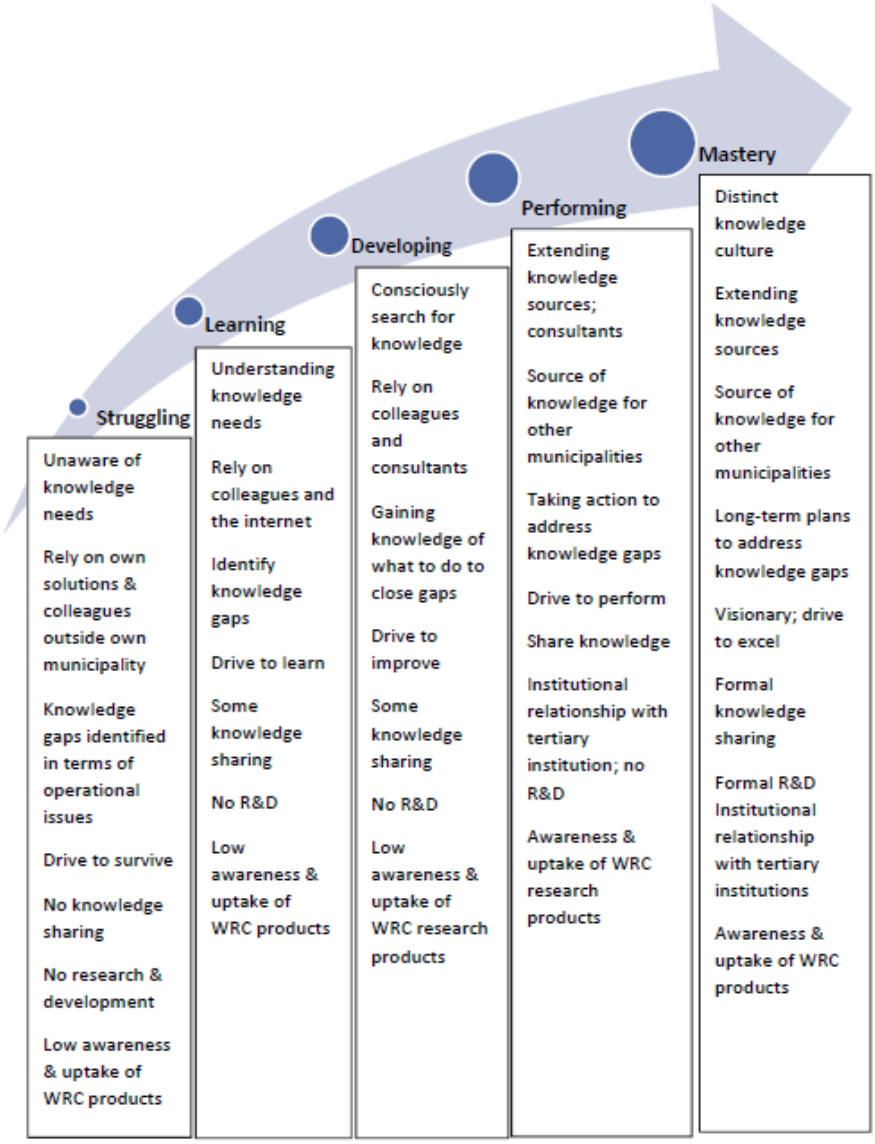


Figure 2.21: Performance roadmap and engagement with research-based knowledge (Slabbert, 2016)

It was furthermore found that that engagement with knowledge in municipal wastewater and sanitation services is influenced by the interplay of a range of factors in both the institutional and the individual domains. A research organisation such as the WRC will have to address both domains in its marketing and research strategies to improve uptake and achieve impact.

In most cases, awareness of the WRC, and even use, was championed by individuals. Most of these knowledgeable individuals are true ambassadors or champions of the WRC. Institutionalised research and development were only found in Ekurhuleni (ERWAT) and eThekwini.

The WRC was well-respected among municipal officials who were familiar with the organisation. A number of misconceptions about the WRC were noted, as well as perceptions that the WRC products are not practical, or ''too academic''.

The research found that different levels of municipal officials differ in their self-reported use of WRC research. Uptake in wastewater and sanitation is limited to a handful of research reports that are used over and over again.

Awareness of the WRC and its research products was found to be particularly low in Local Municipalities (LMs) and District Municipalities (DMs). Without awareness there can be no uptake.

The following priority actions were recommended to improve uptake and impact:
1. Establish a customer database of all municipal officials in wastewater and sanitation. This database will have to be regularly updated.
2. Undertake a basic baseline assessment of these officials' awareness of the WRC.
3. Share the report of this study, or a summary, with these officials.
4. Develop and implement a municipal marketing and research strategy that caters for institutional relations, and individual relations with the database of officials. Assess and improve the strategy every year.
5. A knowledge sharing event where the WRC could share and discuss the findings of this study with its partners in the water sector with the aim of developing an action plan. (The findings of the study were discussed at a Water Institute of Southern Africa (WISA) conference workshop.)
6. Update the reports that are widely used in the municipal wastewater and sanitation space and make sure that all relevant officials have the updates.

Slabbert, S., Green, N. & Van der Stoep, I. 2019. WRC Report No. TT 783/18

In 2017, the WRC contracted BHI32 to explore the journey from research to uptake through a case study on water measuring in commercial irrigated agriculture (Slabbert, Green, & Van der Stoep, 2019). The case study investigated the context and constraints of commercial irrigators in four Water User Associations (WUAs) along the Orange River, regarding water management practices, with specific reference to water measuring and metering. The case study also investigated the knowledge networks of WUA management, growers and their intermediaries.

The primary target groups of this research were the WUA management and growers. The following people were interviewed:

- The Chief Executive Officer of the WUA
- The Chair of the Board, and
- Eight to ten commercial growers per WUA. In total, **36 interviews** were conducted with growers.

The secondary target group of the research was intermediaries who act as knowledge conduits to the primary target groups: organised agriculture, government departments, grower associations, training organisations, consultants, suppliers, other research organisations, NGOs. The research team compiled a list of intermediaries mentioned by the growers. From the list a sample of **21 intermediaries** were interviewed.

Key findings from the case study were the following:

- For decision-making, the growers draw on a network of knowledge sources. In all four studied WUAs, leading growers and intermediaries (advisers) are strong influencers. Each grower has their own network of knowledge sources, but, within a WUA, and even across

adjacent WUAs, the strong influencers tend to be the same people and organisations. The channels through which they access knowledge range from personal interactions and visits to traditional media to the digital space. Personal interactions and mobile phones are preferred channels.

- The WRC does not feature on the map of the knowledge sources that these growers use. This explains why, despite the concerted communication efforts of the WRC and the researchers who produced the reports, guidelines and training material on water measuring and metering, awareness and uptake of this knowledge were found to be disappointing.
- Advisers, in turn, draw on a network of knowledge sources that is very different from the growers. They fill the gap between science and application by collecting, evaluating and translating research-based knowledge for growers into practical and affordable business solutions that they can implement with immediate effect. The WRC features on the advisers' map of knowledge sources although not prominently. It was evident therefore that the WRC should channel its research-based knowledge through these intermediaries to reach commercial irrigators but that it would be essential also to strengthen brand awareness.

Based on the insights from the literature review and the findings of the case study a communication strategy was developed that aims to improve the awareness, acceptance and application of water measuring and metering in irrigated agriculture in South Africa.

As a follow-up, the WRC initiated a project to support water measuring in commercial irrigated agriculture. The project comprised:

- A national roadshow at selected sites to cover all nine WUAs.
- Brief guides for irrigation water measuring and metering. The guides refer to the WRC's reports and guidelines on the topic.
- A new website (watermeter.org.za) with a blog, videos, useful links, news and latest updates and downloadable reports, articles, and presentations.

Indicators derived from the above studies

The findings and recommendations of the above studies suggest several indicators that would demonstrate that the WRC is creating an RDI environment that supports uptake and impact. For example:

- Involving intended beneficiaries as research partners
- An extensive database of stakeholders
- Understanding of the knowledge networks of key stakeholder groups
- An optimized search engine for the WRC's website
- Optimized Google analytics of the WRC website activities (downloads, page visits, citations, etc.)
- Regular stakeholder research to track brand awareness and perceptions of the WRC and its research outputs; a marketing strategy to enhance awareness and address perceptions
- A strategy to regularly update research reports that are widely used
- Communication strategies to facilitate uptake and impact for specific target audiences
- Discussion forums to find common ground between specific target audiences, for example, small-scale farmers, and the WRC
- Follow-up projects to facilitate uptake of specific research outputs.

Chapter 3: First round of stakeholder research

3.1 PURPOSE OF FIRST ROUND OF STAKEHOLDER ENGAGEMENT

Chapter 2 investigated the concept of ''value'', and the value indicators of RDI in general, and water and sanitation RDI specifically, from the perspective of the literature.

This chapter reports on stakeholder engagement that investigated stakeholders' views and expectations, regarding what stakeholders recognise as value in the WRC's RDI programmes and in their interaction with the WRC. The aim was to understand their interpretation of value and what they regard as value indicators.

The stakeholder research also investigated the potential of a common understanding of the value of water and sanitation research.

3.2 APPROACH AND METHODOLOGY

Since this part of the study focusses on gaining a better understanding of the many facets of a complex phenomenon, in-depth individual interviews with a range of stakeholders were selected as the research instrument. Stakeholder surveys tend to give a generalized and over-simplified picture.

3.3 WHO ARE THE STAKEHOLDERS OF WATER AND SANITATION RESEARCH?

3.3.1 Definitions

Freeman's definitions of ''stakeholder'' are widely quoted in the literature on organisational communication:

- "any group or individual who can affect or who is affected by the achievement of the firm's objectives" (Freeman, 1984)
- "those groups who are vital to the survival and success of the organisation" (Freeman, 2004).

Since Freeman's 1984 definition, a proliferation of definitions followed in academic literature. Miles (2011) analysed 435 different definitions from 493 articles and found a new definition every 1.13 articles published. According to Mainardes et al. (2011:228), there is no single, definitive, and generally accepted definition of the term.

In pursuit of inclusive water governance, the OECD (2015:35) defines a stakeholder as: ''Person, group or organisation who has an interest or stake in a water-related topic, may be directly or indirectly affected by water policy, and/or have the ability to influence the outcome positively or negatively''.

The OECD (2015:33) notes the difference between public participation and stakeholder engagement and describes stakeholders and engagement activities as follows:

> *Stakeholder engagement goes beyond civil society and end users, and reaches out to other groups of actors within and outside the water sector in activities related to*

planning, decision making, implementation, and monitoring and evaluation. Stakeholder engagement therefore also encompasses different levels of governments (multi-level governance), the private sector (water stewardship), regulators, service providers, donor agencies, investors, civil society in its different forms (e.g. citizens, non-governmental organisations, users' movements, etc.) and other relevant constituencies.

For the purpose of this study, the research team used the following simple generic definition:

> *Stakeholders represent individuals or groups that hold a stake in water and sanitation research, either because they will be impacted by the research or because they have a vested interest in it* [20]

The WRC TOR for this project lists users, funders, local and national government, farmers, and industries as stakeholders, but a further distinction in the user category between the roles of researchers, consultants and the intended beneficiaries will be made below. (A stakeholder survey [Slabbert, 2014] found that researchers and consultants are the main users of the WRC's knowledge products.) The WRC's RDI partners are also considered as stakeholders in the context of this study.

Stakeholders are usually regarded as external to an organisation, but neither Freeman's definition nor the OECD's exclude internal stakeholders. The WRC has often been described in personal communication as a catalyst in water research, facilitating and affecting its outputs, outcomes and uptake. For this reason, the WRC was included as a stakeholder in this study.

3.3.2 Stakeholder configurations

The classic stakeholder matrix plots stakeholders according to their influence on the outcome of the project and the importance of the project for them (UNDP, 2009), or the impact that the project has on them (UNDP, 2020:36).

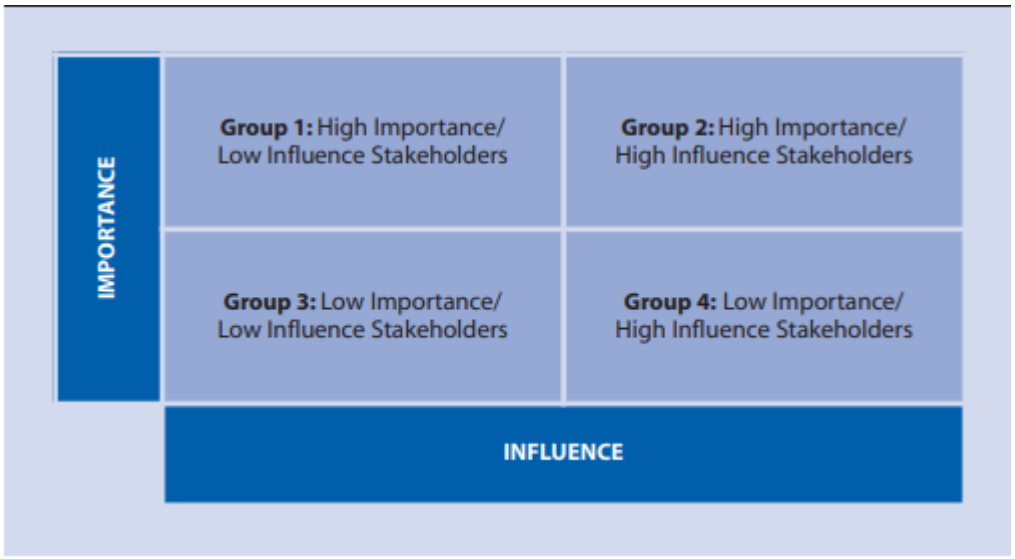


Figure 3.1: Stakeholder matrix (UNDP, 2009)

This study focussed on Group 1 and 2 stakeholders: people for whom the impact of water research is highly important, but whose influence on the outcomes and the uptake varies from high to low.

[20] https://wellingtone.co.uk/stakeholder-management/

3.3.3 Levels of stakeholder engagement

The OECD's document on stakeholder engagement and water sector governance, distinguishes six levels of stakeholder engagement (2015:36) as depicted in the figure below. At each level, stakeholder engagement has a different intention or focus.

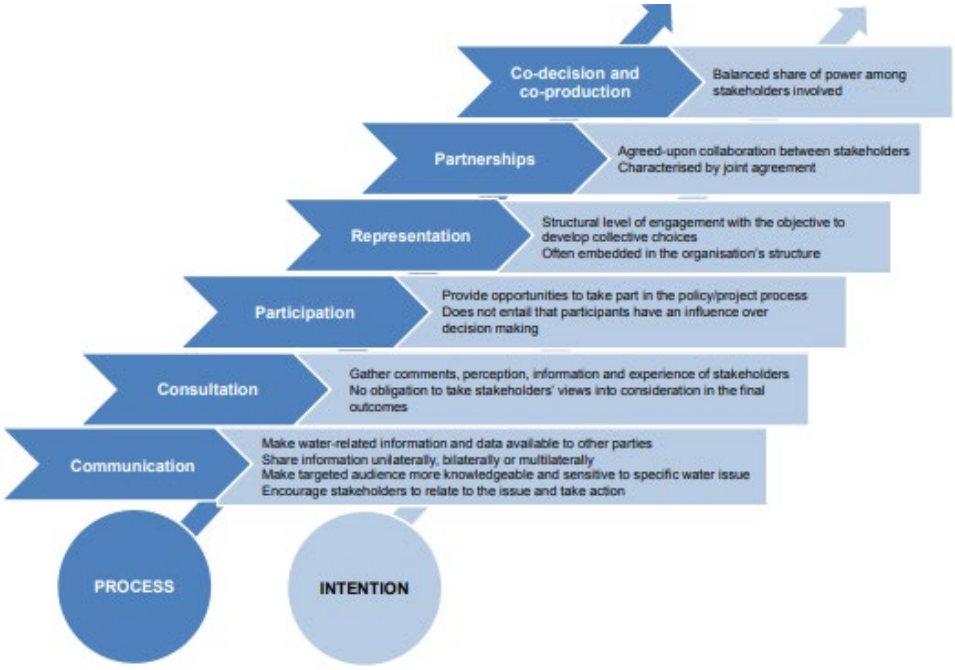


Figure 3.2: Levels of stakeholder engagement (OECD, 2015)

The engagement processes between the WRC as a water research organisation and its external stakeholders take place at all levels. The stakeholder interviews explored the value of the engagement at each of the levels.

3.4 SELECTION OF STAKEHOLDERS

3.4.1 Three groups

Representatives from three stakeholder groups were interviewed:

1. Internal stakeholders
2. Research partners of the WRC
3. Stakeholders of WRC projects.

The three groups and the sampled representatives are discussed below.

3.4.2 Internal stakeholders

Interviews were conducted with the CEO of the WRC, an Executive Manager and the Manager of the Innovation & Impact division.

3.4.3 Research partners

Interviews were conducted with representatives of:

- The Department of Science and Innovation (DSI)
- The Department of Water and Sanitation (DWS)
- SALGA

- South African universities
- The Water Boards.

The Science Councils, such as the CSIR, and consulting companies are also research partners of the WRC. In this study, they were included under the project stakeholders, but the discussion guides included questions on their role as research partners of the WRC.

It is important to note that Project Leaders, who represent the full range of innovation agents (private sector businesses, academic or research institutions, government agencies, state-owned enterprises, NGOs, civil society organisations and interest groups) are essentially also research partners of the WRC.

3.4.4 Stakeholders of WRC projects

3.4.4.1 Approach

For the stakeholders of WRC projects, a case study approach was followed. This was done to avoid vague generalisations, but rather guide project stakeholders to define and describe value with reference to specific project experiences. This approach furthermore enabled the research to team to identify concrete value indicators.

Six WRC projects were identified for the case studies. The selected projects represent the four sectors of the water community as identified in the RDI Roadmap (Agriculture, Industry, Public Sector, Environment), the three key strategic areas (Water use, wastewater and sanitation futures; Water utilization in Agriculture; Water resources & ecosystems). The other sampling criteria and the details of the sample are discussed in the sections that follow.

Only ‘’active’’ stakeholders were interviewed. Previous WRC research has demonstrated that stakeholders who do not even know who or what the WRC is, or who has never been actively involved in a research project, or who has no idea that they were a potential beneficiary would not have an opinion on the value of water and sanitation research that supports the aims of this study.

An ‘’active stakeholder’’ is defined as an individual, group or organisation that has had a productive interaction with the research team of the selected RDI project. Productive interaction is used as defined in Spaapen et al. (2013): An interaction is productive when it leads to efforts by stakeholders to apply research results to social goals, i.e. when it induces behavioural change. The description by Spaapen et al. (2013) puts the research Project Team outside the stakeholder domain. This is incorrect. The research Project Team is a key stakeholder of RDI projects.

For the selection of project-based stakeholders, the study followed ideal knowledge flows and knowledge networks associated with a water and sanitation research project, as depicted in the diagram below.

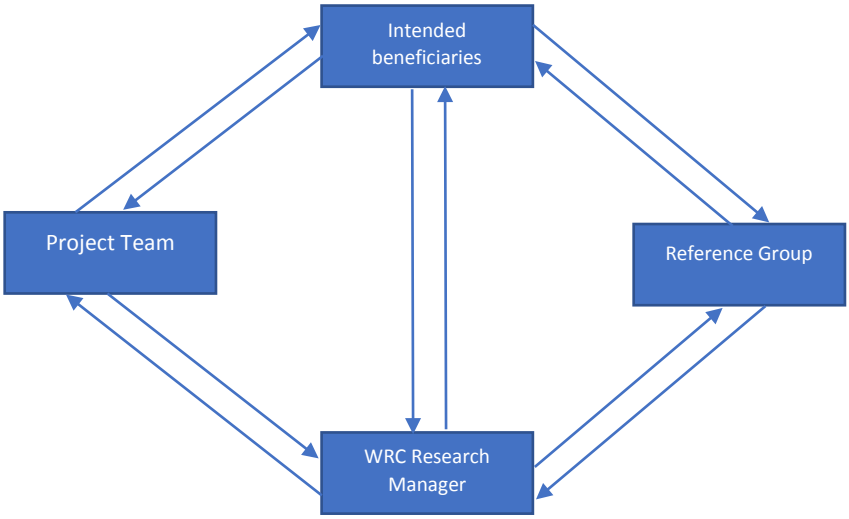


Figure 3.3: Project-based knowledge flows as a starting point for stakeholder mapping (adapted from a diagram by Dr Ashiel Jumman – personal communication)

For the sampled research projects, the interviews therefore included Research Managers, the Project Leaders, Reference Group members, students and intended beneficiaries.

3.4.4.2 Selection criteria for sampled projects

The following selection criteria were used to select a sample of WRC projects:

a. Projects that were completed in the past 15 years. The reasons were practical: it would be easy to find and contact the Project Teams, Reference Groups, Research Managers and representatives of the stakeholder groups.
b. Projects that have had time to ''mature'' in impact. Projects completed in the past two years were not considered.
c. Projects that cover the WRC's business units and KSAs to include a wide range of topics, intended audiences and innovation types.
d. Projects that were mentioned in the WRC Innovation reports of 2018/2019 and 2019/2020, and the WRC SA Innovation storybook. There are several practical advantages of using these documents as source for the sampled projects:
    i. The Innovation reports provide the technology readiness levels of the innovations, which could be added as a criterion. It should be noted that not all projects involve technological innovation; the term ''technology readiness'' should therefore rather be ''ready for implementation/market-ready''.
    ii. The innovation reports indicate the output category of the study, for example, decision support tool, tool/model, process, guideline, method, or device. This enables the researchers to add the type of innovation as a criterion.
    iii. The documents include a short description of each project, its current status and details of the Project Team. This made it easier to ensure that a range of innovations and innovators could be selected.
    iv. It should be noted that the projects included in the Innovation reports and storybook are all at a readiness level of 3-9. They exclude basic research and proof of principle.
e. We did not include our own WRC research projects to avoid bias.

Selecting projects included in the Innovation reports and Storybook skewed the sample towards projects that the WRC wanted to showcase, i.e. projects that the WRC considers to be relevant, innovative and having high impact potential. On the other hand, these projects are considered to have delivered value to stakeholders. And to capture stakeholder value indicators was exactly the aim of this study.

3.4.4.3 The sample projects

The table below set out the final project sample:

Table 3.1: Project sample

Category	Project name and description	Status	Intended beneficiaries	Co-funder
Non-technological: • managerial innovation • decision support tool **KSA**: 3 Water treatment and supply operational costs **Sector:** Public	**WATCOST** (TT 522/13) A costing manual for predicting the cost for the operation, maintenance, and management of water-supply systems.	Used by various stakeholders in the water sector. The technology is not intended for commercial purposes and is freely available from the WRC.	Decision-makers, water supply authorities, consultants, engineers, planners, and DWS	No
Technological (TRL[21]7-9): • product • new device **KSA**: 3 Hydro-energy generation **Sector**: Public	**Small-scale hydropower plants** (TT 597/14, KV 238/10) A scoping study and pilot projects on the feasibility of hydropower in South Africa.	The status of the projects varies. More details are given in 0.	Municipalities, water boards, communities	DSI
Non-technological: • managerial innovation • creative social response • tool/model **KSA**: 1&2 Water quality management **Sector**: Environment	**miniSASS** (KV 240/12, TT 639/15, TT 763/18) Citizen science tool.	Widely deployed throughout SA and other countries	NGOs, communities and schools	WESSA provided support

[21] Technology Readiness Level

Category	Project name and description	Status	Intended beneficiaries	Co-funder
Technological (TRL9): • product • new device **KSA**: 3 Sanitation **Sectors:** Public & Environment	**Pour flush toilet** (2203/1/18) Design, develop and test pour-flush toilets in a South African context.	Following successful piloting of the pour flush toilets in 2010 and 2011 in Kwa-Zulu Natal. These pilot projects saw strong support from government institutions, municipalities and civil-society organisations. Environsan Sanitation Solutions provided expertise and support for upscaling the project in 2012 and have since commercialised the pour flush toilet.	DWS, municipalities, households	Environsan provided support
Non-technological: • new business model • new method **KSA**: 3 Sanitation **Sectors:** Public & Environment	**Social franchising** (KV 161/05) involves small enterprises which enter a business partnership as franchisees with a franchisor, using a "tried and tested" approach for undertaking the activities required to ensure that sanitation, water facilities and other systems are operating in a reliable manner and to suitable hygiene standards.	The Eastern Cape Department of Education was the first to adopt social franchising and approve a pilot project. Considerable interest shown by metropolitan municipalities in South Africa.	Small enterprises, rural villages, schools and peri-urban areas.	Follow-up study funded by Irish Aid
Technological (TRL9): • product • new device **KSA**: 4 **Sector**: Agriculture	**ElectroFlo electronic water meter** (1190/1/04) A device to measure water use indirectly.	Commercialised – https://flocheck.co.za/	DWS, WUAs, commercial farmers	No

3.5 THE INTERVIEWS

In total, 30 in-depth interviews were conducted with the three stakeholder groups. The interviews were online using Microsoft Teams and were recorded for analysis purposes.

The discussion guide used for each stakeholder group appears in the Appendix A. The discussion guide was slightly adapted for each individual stakeholder and project.

3.6 INTERVIEW SUMMARIES

The summaries of the interviews with the internal (WRC) stakeholders and the research partners appear in Appendix B.

The summaries of the interviews with project stakeholders appear in Appendix C.

Chapter 4: Analysis of stakeholder value

4.1 SUMMARY OF STAKEHOLDER VALUE AND INDICATORS

4.1.1 Research partners

In the subsections below, the value that WRC RDI has for research partners, as mentioned in the stakeholder interviews, and the indicators of this value (mentioned by stakeholders or derived from the literature review), are summarised:

4.1.1.1 Department of Water and Sanitation: official 1

Table 4.1: DWS official 1: value and indicators

Value	Value indicator
WRC research offers solutions to DWS	• DWS value expectation of WRC in line with mandate • Time that it took DWS officials to learn about the WRC and its research • Time that it took DWS official to use WRC research • Recall of WRC research and use • Time that it took DWS official to become involved in WRC research, e.g. as Reference Group member
The WRC gives DWS opportunity to influence research agenda and performance plan	• No of bilateral conversations and agreements • Qualitative feedback: the WRC targets the right branches of DWS
WRC addresses DWS' research needs (specific to sanitation)	• More research on low water/waterless technologies • Decision support tool for municipalities to select appropriate sanitation technology • Guidance on economic and practical benefits of sanitation value chain
DWS uses WRC research (uptake)	• Institutionalised relationship • Changes to strengthen institutional relationship • Regular bilaterals versus ad hoc contact • DWS involvement in research projects quantified (no of Ref Group members; active participation; input in deliverables; co-authors, etc.) • DWS empowered to influence uptake (e.g. endorsing new sanitation technologies) • NEG: DWS not involved in research; only expected to read reports • NEG: minimal aftercare
DWS is empowered in relationship with EWSETA	• WRC has partnered with DWS in deliberations with EWSETA

4.1.1.2 *Department of Water and Sanitation: official 2*

Table 4.2: DWS official 2: value and indicators

Value	Value indicator
International standing of South Africa's water research/sector	• No of international keynotes that WRC is invited to • No of publications in international peer-reviewed journals and citations •
The WRC gives DWS access to world-class research solutions/''service''	• Institutionalised relationship between the WRC and Planning • Individual qualitative feedback • No of opportunities for DWS officials to brainstorm solutions with WRC research managers • WRC has the best resources in SA on its research projects
The WRC offers DWS a reliable implementing agent with a credible procurement process	• No or DWS projects with the WRC as Implementing Agent
Capacity building and opportunity to contribute to research	• No of DWS officials actively involved in WRC projects (See DWS official 1) • Cooperation between WRC and DWS Learning Academy

WRC has access to WRC research-based knowledge	• Example of dam silting project:
	  ○ Videos (overview of research and findings)
	  ○ Symposia (opportunity to bring together diverse group of people to debate implementation strategy)

Research-based knowledge with practical application value for DWS (uptake)	Indicators that basic requirements for uptake are met: • Clear role delineation • Ownership of roles • Awareness of WRC within DWS (see official 1) • Mutual respect • WRC aware of day-to-day challenges of DWS (liaison officer) Indicators of improvement • Mechanism to shorten project cycle in specific circumstances • No of graduates in Learning Academy targeted • Mechanism of DWS officials aware of available research • Liaison officer

4.1.1.3 *The Department of Science and Innovation*

Table 4.3: DSI: value and indicators

Value	Value indicator
Return on Investment	• No of WADER projects that reached the marketplace • No of water projects used by decision makers; evidence that research has translated into policy and solutions (DWS) • No of innovation opportunities identified by Blue/Green Drop

Value	Value indicator
	• No of commercialised or scaled up sanitation technologies funded by SASTEP • Evidence of coordination between initiatives (WATER, TIA, SASTEP) – lacking at moment • More money invested in water research annually • Increasing number of co-funded research outputs • No of international institutions involved in co-funded projects • Evidence of political buy-in, for example the ecological infrastructure indaba • WRC has database critical individuals and levers in water sector system; evidence that research managers collaborate with them
DSI is able to influence the water sector (WRC as a powerful enabling ally)	• Indicators of the WRC's international reputation (see under DWS, SALGA and Universities) • No of co-funded projects successfully commercialised or scaled up
DSI's own views and approaches enriched	• Qualitative feedback

4.1.1.4 SALGA

Table 4.4: SALGA: value and indicators

Value	Value indicator
Return on investment	Indicators of a successful partnership • No of Reference Groups that SALGA are active in • No of co-funded projects • Positive perception of collaboration • SALGA not player and referee
Municipalities are using WRC research	General indicators: • Institutionalised mechanisms that support the WRC's research partners to use the research, involving National Treasury, DWS, SALGA, the WRDC and other relevant stakeholders. • SALGA agreement with CESA to ensure that knowledge is used by consultants Indicators that the WRC is facilitating uptake: • Personal contact/relationships with key actors such as the research managers • Collaboration with key actors • MoUs • WRC partners in stakeholder programmes (for example the benchmarking programme)
The WRC addresses SALGA's research needs	Indicators that the WRC is delivering on expectations: • Mutual agreement on expectations • Agreement on what needs to be done: deliverables and funding instrument • SALGA involved in WRC's strategic planning • Evidence-based research • WRC procures world-class researchers

	Indicators that research needs are taken up adequately: • Structured actions to encourage municipalities to communicate their research needs – participants must understand the WRC and the value that they have to offer/their mandate • Cooperative structures like the new Technology and Innovation Forum are regularly assessed and improved Indicators of that WRC can respond to SALGA's specific research needs • The WRC has a flexible project cycle.
SALGA is a player on international municipal water forums: The WRC involves SALGA in relevant international agreements	• SALGA is part of important international agreements and relationships
Value at research project level	• SALGA takes part in conceptualising and defining the project • NEG: project that are not implemented.

4.1.1.5 Higher Education institutions

Table 4.5: Higher education institutions: value and indicators

Value	Value indicator
Capacity building	• No of postgraduate qualifications • No of patents registered
Economic impact	• No of publications in peer-reviewed journals • Employment positions of postgraduate students
Innovation impact	• No of commercialised patents
Ecological impact	• Project-specific: for example, improved mine water (a baseline is required)
Financial impact	• No of jobs created
Personal value for researchers	• Qualitative feedback: interesting and stimulating topics • Satisfaction to see application value of research • Involvement in high profile research
Knowledge exchange	• Time to publish and share findings
Research on a specific topic is coordinated nationally or regionally	• The WRC has set up a mechanism to coordinate research between high education institutions
WRC is addressing critical research needs of RSA	• Qualitative feedback
WRC is a world-class research partner	• WRC has database of top researchers in the country and involving them in research projects • WRC has mechanism (database) to identify upcoming black research leaders and involve them in research projects
In capacity as WRC Board member:	
WRC provides world-class solutions to water and sanitation challenges of SA	• Project- or challenge-specific evidence • No of citations of Water SA

	• No of black research managers with specialist research skills • Mentorship programme for these research managers • See also previous indicators
Upscaled testing of solutions	• No of large-scale projects • Rx million supplementary research funding leveraged from external sources

4.1.1.6 Water Boards

Table 4.6: Water Boards: value and indicators

Value	Value indicator
WRC addresses research needs (uptake)	• Formal MoUs • Regular opportunities for individual research partners to voice their research needs. Not all research partners are comfortable to voice needs on a public platform because it might display weaknesses. • NEG: the PFMA restricts procurement of innovation partners
Knowledge exchange	• A mechanism to inform stakeholders of what research is coming out by when and to highlight link to past research project. For example, short video clips and discussions on specific projects at conferences

4.1.2 Project stakeholders

In the subsections below, the value that WRC RDI has for the stakeholders of the sampled WRC projects, as they mentioned in the interviews, and the indicators of this value (mentioned by stakeholders or derived from the literature review), are summarised:

4.1.2.1 Project leaders

Table 4.7: Project leaders: value and indicators

Project	Value	Value indicator
WATCOST Consultant (SMME)	Stimulating work, opportunity to be creative Work/money Contribute to a solution: assist municipal officials with a practical tool	• Return for more projects • Qualitative feedback

	Lead to spin-off projects or further WRC projects
	Knowledge that he can apply in training and consulting
		• Spinoffs:
		  ○ Other research projects
		  ○ Apply in training and consulting

	Reputation	• Publications, presentations, awards • Citations
	Interesting, challenging, fulfilling Contribute to a solution	• Return for more WRC projects • Qualitative feedback

Project	Value	Value indicator
Small-scale hydropower plants Academic	Enhance reputation; put on international platform	• Number of conferences papers and other presentations • Number of articles in peer-reviewed journals • Number of articles in popular magazines • Number of awards • Invitations • Citations • Number of postgraduate students who worked on the topic
	Advance academic career	• Career path and awards
	Networks of knowledgeable and interesting people	• Spinoffs: Research on other, but related topics • Funding partners
	Student exposure: research opportunities, practical experience, bursaries	• Number of postgraduate qualifications associated with project
	University: • Status • Funding • New courses and course material • Equipment	 • Awards related to project • Funding received • Number of courses related to project • Capital budget, assets bought

Project	Value	Value indicator
miniSASS SMME working closely with NGOs	Interesting topics Financial resources Contribute to a solution	• Return for more projects • Qualitative feedback
	Lead to spin-off projects or further WRC projects Develop expertise in citizen science Networking opportunities	• Return for more projects • Number of related projects • Qualitative feedback
	Reputation	• Number of conferences papers and other presentations • Number of articles in peer-reviewed journals • Number of articles in popular magazines • Number of awards • Invitations • Citations • Number of post graduate students
Pour flush toilet Consultant (SMME)	Improves understanding, answers questions Contribute to a solution Work/money	• Return for more projects/bid histories • Qualitative feedback
	Lead to spin-off projects or further WRC projects	• Return for more projects • Spin-offs: Research on other, but related topics

Project	Value	Value indicator
Social franchising Researcher at CSIR	Interesting topics which are of use to society. Contribute to social good	• Return for more projects • Qualitative feedback
	Lead to spin-off projects or further WRC Projects	• Return for more projects • Number of related projects • Qualitative feedback
	Advance academic career	• Number of conferences papers and other presentations • Number of articles in peer-reviewed journals • Number of articles in popular magazines • Number of awards • Invitations • Citations
	CSIR: can get more funding	• More funding based on number of research projects
ElectroFlo meter Entrepreneur	Opportunity and funding: could test a prototype and refine it Contribute to a solution	• Returned to WRC as Ref Group member or part of Project Team • Qualitative feedback
	Commercial success: • Product that could be commercialised • Self-employed: own company	• Commercial product (patents, trademarks) • Company (no of years, sales, annual growth)
	Networking opportunities	• Sales and spin-off projects

4.1.2.2 Reference Group members

Table 4.8: Reference Group members: value and indicators

Project	Value	Value indicator
WATCOST	Learning experience	• Qualitative feedback
	Personal satisfaction	• Student learnings (difficult to measure)
Small-scale hydropower plants	Keep abreast of latest research Networking: Identify collaborating opportunities	• Number of related projects and partnerships
miniSASS	Learning experience Opportunity to contribute	• Qualitative feedback
	Networking Take knowledge back to sphere of work	• Number of related projects and partnerships
ElectroFlo meter	Learning experience Access to new knowledge	• Qualitative feedback
	As lecturer: • Applied knowledge in course material • Identified topics for final year engineering students	• Number of courses with reference to WRC research • Number of final year topics related to WRC research
	Networking Parallel projects	• Number of related projects and partnerships

4.1.2.3 *Beneficiaries of the WATCOST model*

Table 4.9: WATCOST beneficiaries: value and indicators

Beneficiary	Value	Value indicators
Water supply authorities, consultants, engineers, planners	Success/uptake	• Number of users (implies there is a tracking mechanism)
	User experience (e.g. user friendly and easy to update)	• Feedback from users: user experience
	Knowledge exchange	• Number of workshops • Number of conference presentations
Students	Capacity building	• Number of students

4.1.2.4 *Beneficiaries of the small-scale hydropower projects*

Table 4.10: Hydropower beneficiaries: value and indicators

Beneficiary	Value	Value indicators
KwaMadiba community	Job creation and skills development	• Number of PPPs associated with a project • Number of local people employed on project • Number of local people trained
	Social empowerment and sense of pride	• Buy-in from local community • Opinions and experiences of the beneficiaries. (Impact stories)
Bloemwater: technician involved in project	Interesting: found his niche Life changing	• Opinions and experiences of the beneficiaries. (Impact stories)
	New knowledge: personal growth and built expertise	• Number of publications, presentations • Citations • International visits • Training received • Consulting opportunities
	Networks: Exposure to interesting people	• Consulting opportunities
	Opportunities to travel	• International visits
Bloemwater	Publicity	• Number of media articles • Number of visitors from other institutions and/or other countries
	Sustainability	• Life span of technology
	Cost saving	• Monetary savings
	Spin-off projects and upscaling	• Number of spin-off projects completed • Upscaling completed
Student	Personal satisfaction Contribute to a solution/social goal	• Return as Project Leader of WRC project
	Networking	• Career path
	Qualification	• Qualification • Further qualifications/study

Beneficiary	Value	Value indicators
	Recognition and exposure	• Number of conferences papers and other presentations • Number of articles in peer-reviewed journals • Number of articles in popular magazines • Number of awards • Invitations • Citations
	Career path choice	• Promotion

4.1.2.5 Beneficiaries of miniSASS

Table 4.11: miniSASS beneficiaries: value and indicators

Beneficiary	Value	Value indicators

NGOs, communities and schools	Uptake and impact	• Participation of organisations like Palmiet River Watch
		• Initiatives like Envirochamps:
		  ○ Number of people involved
		  ○ How often are they active?
		  ○ What have they achieved?
		  ○ Have they grown?
		• Uptake by other organisations like DUCT (formal vs informal)
		• Number of trainees per year
		• River health/environmental improvement
		• Behaviour change (need a baseline) – industries and municipalities
		• Impact stories – change in quality of life

	Knowledge exchange	• Uptake by teachers in schools • Participation in national water days • Google analytics of online platform • Continued support/follow through
	Capacity building	• Number of postgraduate studies on topic of citizen science referencing miniSASS • Number of learners studying further in science • WRC activities: bought miniSASS tool, sponsored demos and training:
Student	Challenging learning journey	• Qualitative feedback
	Networking Expanded knowledge of sector	• Career path • Qualitative feedback
	Qualification	• Qualification • Further qualifications/study

Beneficiary	Value	Value indicators
	Career path choice	• Promotion

4.1.2.6 Beneficiaries of the pour flush toilet

Table 4.12: Pour flush toilet beneficiaries: value and indicators

Beneficiary	Value	Value indicators
DWS, municipalities, households	Success/uptake	• Number of toilets sold/put up • Commercialised product • Product enables users to move up on sanitation ladder • Solution to current challenge • Level of upscaling • Number of spin-offs (alternative products) • Value-adds (sludge management) • Product endorsed by government
	User experience (e.g. low maintenance, easy to use, feeling of dignity)	• Feedback from users: user experience • Condition of toilets over time • Impact reports
Students	Capacity building	• Number of students • Project leader acting as co-supervisor

4.1.2.7 Beneficiaries of social franchising project

Table 4.13: Social franchising beneficiaries: value and indicators

Beneficiary	Value	Value indicators
Franchisor (research partner)	Contribute to a solution Work/money	• Qualitative feedback
	Lead to spin-off projects or further WRC projects	• Return for more projects • Number of related projects • Qualitative feedback
	Reputation	• Number of conferences papers and other presentations • Number of articles in peer-reviewed journals • Number of articles in popular magazines • Number of awards • Invitations • Citations
Amathole DM	Upliftment of schools and households Better level of service	• Number of pits emptied/toilets cleaned • Qualitative feedback
	Impact of environment	• Number of pits emptied/toilets cleaned
	Reduces backlog	• Number of pits emptied/toilets cleaned
Franchisee	Training	• Number of franchisees trained

Beneficiary	Value	Value indicators
	Work/income Employees	• Number of jobs created
	Publicity	• Number of media interviews • Number of invitations

4.1.2.8 Beneficiaries of ElectroFlo meter

Table 4.14: ElectroFlo meter beneficiaries: value and indicators

Beneficiary	Value	Value indicators
DWS, WUAs and commercial farmers	Uptake and impact	• Commercialized • Number of water meters installed • Regulations to accelerate uptake • Number of follow-up projects (focused on technology transfer) • Multi-channel approach • Value-add (App, modem, electricity and fertilizer application)
	User experience (cost effective solution)	• Qualitative feedback • Impact stories
	Water use efficiency	• Number of WUAs who have installed water meters • Number water meters installed • Direct abstractions from river: Reconciliation of licenced water use and actual water use • Reduction in water unaccounted for • Greater water use efficiency in agricultural sector
Students	Capacity building	• Number of students involved in • Number of testing sites

4.1.3 General indicators

In addition to the above indicators, the stakeholders identified general value indicators of WRC RDI. Below is a summary.

Table 4.15: General value indicators of WRC RDI

Category	Value indicators

Creating an environment that is conducive for RDI uptake and impact	• WRC is a player in the global water sector
	  ○ How SA research does on international platforms
	  ○ Perceptions of good quality research and engineering
	  ○ Number of experts in applications of research
	  ○ Strength of water industry: perception that it is technically competent
	  ○ Presence at international conferences
	  ○ Invitations to plenaries
	  ○ Working relationship with other leader organisations
	  ○ Contribution of WRC researchers in peer reviewed water research.
	• WRC is a solution provider and a catalyst for innovation
	  ○ Number of needs-based solutions offered in each field

Category	Value indicators
	○ Quality of solutions ○ Target group awareness of solutions ○ Solutions are used • Environment that is open to RDI: ○ More technical expertise in DWS and municipalities ○ Organisation sees relevance and value in RDI ○ Leadership is aware of the WRC and engages with the WRC ○ Not dependent on consultants • Responding to changing environment: ○ Research organisation's focus and shift in focus over time ○ Organisational structure: BDI branch to address upper stages of innovation cycle • Partnerships ○ Number of formal agreements between WRC and research partners ○ Regular opportunities for research partners to voice their research needs ○ Government involvement as co-funder and research partner ○ International and local funding; funding by intended beneficiaries • Reference Groups ○ Active participation and feedback on project management ○ 360-degree coverage: Include academics Include people with skills in commercialization and marketing Include intended beneficiaries Include young (mentored) researchers ○ Inform members about their role • Research Managers ○ RMs who like new and innovative things ○ RMs see potential value/ impact (visionary RMs) ○ RMs who get money into WRC research projects ○ RMs act as a catalyst to start research process
Planning for uptake and impact	• Available budget per project for knowledge exchange activities or a bonus/incentive for uptake • Knowledge Hub: easy to use and easy to find information • Awareness of WRC and its work • Mechanisms put into place to drive uptake and impact, e.g. platforms and repositories, website capability to measure • Include uptake and impact in staff's KPAs • Institutional vehicles to get solutions to marketplace: WADER & SASTEP • Involve main stakeholder/end-user in the research (co-creation)
Outputs	• Number of reports • Number of products • Number of qualifications • Mechanism to ensure outputs can be measured and researchers are held accountable for what they promised in the proposal
Knowledge exchange	• Tailored communication (re-packaged information); supplement reports with new communication instruments • Target group focused/tailored workshops • Number of (interactive) workshops • Feedback at workshops • Number of practical training sessions (field-based) • Number of conference papers and presentations • Number of publications and articles (journal and trade)

Category	Value indicators
	• Number of policy and technical briefs • Number of reports for DWS's bluescreen • Number of meetings (with municipalities) • Number of key consultants trained in the latest and relevant information (CESA workshops) • A system to inform stakeholders of what is coming out and by when • Number of videos, competitions, prizes • High level local and international recognition • Test products on site of intended beneficiaries
Uptake	• Number of downloads from website • Number of guidelines/policies gazetted • Number of follow-up projects • Number of people trained • Number of jobs created (for example the social franchising project) • Number of students • Mechanism to track citations of WRC research
Impact	• Overall RDI as percentage of GDP • Cost-benefit analysis (only for some projects) • Performance progress (e.g. Blue and Green Drop) • Number of impact studies
Internal capacity building	• Financial and other support to staff to upscale their qualifications • Number of qualifications that staff got
Contribution to future research (sustainability)	• Number of follow-up projects, spin-offs or technology improvements • Long-term ecosystem for sustained support (for example, funding for a website) • Mechanism to regularly update products (e.g. tools and models like WATCOST) • Mechanism to manage pool of models/tools/guidelines developed by WRC research • Mechanism to follow up with beneficiaries: where are they X years down the line? • Proper handover programme/mentorship of new RMs so that they can build networks

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Appendices

APPENDIX A: DISCUSSION GUIDES FOR FIRST ROUND OF STAKEHOLDER RESEARCH

WRC internal stakeholders	**Aim of question**
Dhesigen Naidoo/Valerie Naidoo:	
1. From the WRC's perspective, when would you call a WRC research project a success? Explore reasons for answer.	Value in investment in RDI: What does it mean for the WRC?
2. Again, from the WRC's perspective, is there a difference between a successful project and a project that has delivered value to the WRC? Explore in detail.	Same as above
3. The WRC 5-year plan of 2018-2023 states *The WRC strategy is re-enforced with a business development focus to ensure projects can be scaled up with implementation partners for greater uptake and diffusion*. From the perspective of the WRC, is ''value'' and ''uptake and impact'' the same thing?	Clarifying terminology
4. Would you therefore say that uptake and impact fall within the ambit of the WRC's mandate?	Exploring roles and responsibilities in terms of uptake and impact
5. The Plan also states *A paradigm switch is thus, required to take research outputs into outcomes and impact for the broader society*. What are research outcomes and how do they differ from research impact?	Clarifying terminology
6. What do you regard as the best indicators that the WRC has delivered value for tax payers' money (water levy)?	<u>Output</u> indicators of value from WRC perspective
7. What are the indicators that the WRC supports or facilitates uptake and impact of RDI projects:	<u>Process</u> indicators of value from WRC perspective
a. In terms of the research environment?	
b. In terms of the proposal and reviewing process?	
c. In terms of the project roll out?	
d. In terms of project follow on: taking the knowledge into implementation beyond the end date?	
8. IF RESPONDENT MENTIONS AN INDICATOR THAT IS NOT MEASURABLE, ASK: How would you measure X?	Exploring indicators that are difficult to measure
9. Any areas where you feel the WRC can do more, or do things differently?	Exploring roles and responsibilities in terms of uptake and impact

10. Innovation and Impact is a separate branch within the WRC. Why is Innovation and Impact separated from R&D?	Indicative of a supporting environment or not
Mandla Msibi:	
1. The TOR of the project refers to the value of investing in RDI. How would you define the value of RDI?	Value in investment in RDI: What does it mean for the WRC?
2. Innovation and Impact is a separate branch within the WRC. Why is Innovation and Impact separated from R&D? Explore in depth.	Indicative of a supporting environment or not
3. What does your division do to facilitate innovation and impact? Explore stakeholder networks and stakeholder relationships.	Actions that can be included in the indicators (output or process indicators)
4. What about uptake? Is it part of your mandate?	
5. What are your most successful actions? What are your least successful actions?	
6. What are the performance indicators of your division, Innovation and Impact? Explore if they are general or project-specific, or both.	
7. How do you measure these indicators?	Investigate the measurability of possible indicators
8. What is your biggest challenge in meeting your performance indicators?	Evaluate which actions should not be included as process indicators

Research partners	**Aim of question**
DSI/DWS:	
1. DWS: You personally have partnered with the WRC to find solutions that DWS needs. In general, would you say that the WRC is the first port of call when the Department is looking for a water or sanitation research-based solution? Explore in depth.	Position of the WRC in DWS's knowledge network
2. IF NEGATIVE RESPONSE: How do think the WRC can address this?	
3. When would you say a WRC research project has delivered value to DSI/DWS? Explore reasons for answer.	Value in investment in RDI: What does it mean for the [DSI/DWS]?
4. What are the different roles in which DSI/DWS partner with the WRC?	Exploring partnerships
5. Are there some partnership roles that deliver more value to DSI/DWS than others? What is the reason for your answer?	Exploring indicators of value
6. From your perspective, which WRC project has delivered the most value for DSI/DWS? Why?	

7. Which WRC project has delivered the most value for you personally? Why?	Exploring interpretation of value and indicators of value
8. From your perspective, which WRC project delivered less value than DSI/DWS expected? Why?	
9. What can the WRC do to deliver more value to DSI/DWS? Explore in depth.	
SALGA:	
1. Tell me about SALGA'S relationship with the WRC. How did it start? How did it develop?	Position of the WRC in SALGA's knowledge network
2. How do you communicate your research needs with the WRC?	
3. Does the WRC also communicate research opportunities to SALGA?	
4. The WRC's project time frame is usually more than 12 months. Is that a problem for SALGA?	
5. What are the different roles in which SALGA partner with the WRC (client, research manager, funder, co-researcher)?	Exploring partnerships
6. What do you expect from a WRC project that SALGA funds or co-funds?	Value in investment in RDI: What does it mean for the SALGA?
7. In general, what is the value that the WRC delivers to SALGA?	
8. From your perspective, which WRC project has delivered the most value for SALGA? Why?	Exploring interpretation of value and indicators of value
9. From your perspective, which WRC project delivered less value than SALGA expected? Why?	
10. What can the WRC do to deliver more value to SALGA?	

Project stakeholders	**Aim of question**
Research Manager:	
1. When would you call a WRC research project a success? Explore reasons for answer.	Value in investment in RDI: What does it mean for the WRC?
2. Is there a difference between a successful project and a project that has delivered value to the WRC? Explore in detail.	Same as above
3. What do you regard as the best indicators that the WRC has delivered value for tax payers' money?	Output indicators of value from WRC perspective
4. Now let's talk about project X. Has this project been a success from your perspective? Explore reasons for answer.	Success indicators from WRC's perspective. Exploring link between perception of success and value.
5. What is the ''problem'' that this project addressed?	Exploring the rationale for the specific project.
6. Who were the intended beneficiaries of the project? (ask only if not answered in previous question)	Identifying beneficiaries

7. Do you know if the knowledge changed anything? In other words, did it have any impact? If No, what change/impact would you have liked to see?	Value in investment in RDI for specific project's beneficiaries
8. What could the project team have done to improve uptake and impact for the intended beneficiaries of this project?	Exploring roles and responsibilities ito uptake and impact Process indicators of value from WRC perspective
9. What could the WRC have done to improve uptake and impact for the intended beneficiaries of this project?	
10. What is the value that this project had for the WRC? And for you personally?	Value in investment in RDI for specific project
11. As a research manager, how do you ensure that the knowledge that your projects produce is taken up by the intended beneficiaries?	Exploring process indicators
Project Leader:	
1. Why do you do research projects for the WRC? Explore in depth (for example, how many projects have you done? Will you continue submitting more proposals?)	Key metric of value
2. Has this project been a success from your perspective? Explore reasons for answer	Success indicators from Project Leader's perceptive. Exploring link between perception of success and value.
3. Who were the intended beneficiaries of the project? (ask only if not answered in previous question)	Identifying beneficiaries
4. Who or what influence their decisions about [X]? Explore in detail. How do you know that? How was this information used in the project?	Exploring stakeholder networks. Was knowledge networks known and applied to facilitate uptake and impact?
5. Do you know if the intended beneficiaries used the knowledge that the project generated?	Exploring value of RDI investment for beneficiaries
6. Do you know if the knowledge changed anything? In other words, did it have any impact? If No, what change/impact would you have liked to see?	
7. What is the ''problem'' that this project addressed?	Exploring rationale for project
8. If you look back at what you had written under ''Outcomes and expected impacts'', did the project achieve this?	Exploring the link between proposal and actuals
9. What is the difference between the outcomes and the outputs of a WRC study?	Clarifying terminology

10. The knowledge exchange activities: Did it have value? What value? For whom? In hindsight, what would you have done differently to get more [descriptor] value?	Exploring indicators of value
11. Did the project build any capacity? Explore in detail?	
12. What is the value that this project has had for you personally?	
13. What is the value that this project has had for your company/institution?	
14. What can the WRC do to improve value for you?	
15. And what could the WRC have done to facilitate uptake and impact for the intended beneficiaries of this project?	
16. What could the project team have done to facilitate uptake and impact for the intended beneficiaries of this project?	
Reference Group member:	
1. You were a Reference Group member of Project X. Have you been a Reference Group member of a WRC project before? Why did you agree to become a Reference Group member of project X?	Expected value
2. What was your contribution to the Project?	Conscious effort to unlock value
3. What value did involvement in this project have for you personally?	Personal value and possible indicator
4. What value did your involvement have for your organization?	Organizational value and possible indicator
5. How would you compare the value of this project for you with previous projects where you were also a Reference Group member? What was the reason for the difference?	Comparative value and possible indicators
6. What could the Research Manager or the Project leader have done to deliver more value to you?	Actions to unlock value
7. Did the project deliver value to the intended beneficiaries? If Yes, how? If No, why not, and what could have been done to deliver more value to the intended beneficiaries?	Actions to unlock value
Beneficiary:	
1. Have you heard of the Water Research Commission?	Awareness
2. Are you aware of Project X?	Awareness
3. How were you made aware of the project?	Indicators of knowledge exchange
4. Have you personally benefitted from Project X? If yes, how? If No, why not?	Indicators of uptake and impact
5. Has your organization benefitted from Project X? If yes, how? If No, why not?	Indicators of uptake and impact

6. How could you or your organization have benefited more from Project X	Actions that could facilitate uptake and impact

Student:	
1. You completed your Honours/Masters/PhD in 20XX. Tell me more about your research. How did it all happen? How did you get involved in Project X?	Awareness of WRC involvement
2. Did you get a bursary for your study?	
3. Apart from your research paper/dissertation/thesis, what other publications or presentations followed from your research?	Bibliometrics – knowledge exchange indicators
4. Do you track citations of your research? If Yes, ask for detail	
5. What value did this study have for you personally?	Exploring value indicators
6. How did you benefit from this study? Did it help you to get a job? A better salary?	

APPENDIX B:
FIRST ROUND OF STAKEHOLDER RESEARCH: INTERVIEW SUMMARIES

Internal stakeholders

Mr Dhesigen Naidoo, CEO

This interview has been transcribed.

From the WRC's perspective, when would you call a WRC research project a success?

A research project is technically a success when it fulfils the objectives of project in general. Sometimes it goes beyond the objectives of a project. Very rarely does it go below the objectives of the project because we have a research management system that is quite thorough. Because each research project has a Reference Group and if there are variations during the course of the project, they are corrected by the Reference Group. Right tracking the research leaders on the one hand or organising for a change of the objectives with an amendment of the contract on the other hand.

Again, from the WRC's perspective, is there a difference between a successful project and a project that has delivered value to the WRC?

That is an interesting question and there is an interesting philosophy behind it naturally. In general, no, because impact is a measure of the value proposition. That is what is engaged when you are approving the project in the first place. So, in general perhaps not.

There will be value in projects that don't have an impact in the classical sense. You can have something that increases the realm and the sphere of the knowledge generated as opposed to it having a direct impact on somebody's quality of life or the quality of the water services directly but that new knowledge that is created has the potential of going exactly in that direction. Just further upstream on the value chain.

The WRC 5-year plan of 2018-2023 states The WRC strategy is re-enforced with a business development focus to ensure projects can be scaled up with implementation partners for greater uptake and diffusion. From the perspective of the WRC, is ''value'' and ''uptake and impact'' the same thing?

No, it isn't. It is about the placement on the value chain because the WRC as opposed to some of our partners in the GWRC is not an association-based organisation. Our colleagues in Australia for example or in the UK and one of our colleagues in the Netherlands is association-based which means those associations have an agenda on very specific questions being answered from an RDI perspective. To have an immediate plugin point with what they require in their utilities and their industries.

WRC does not do that. Because we are not association-based we actually need to fulfil the needs of the whole value chain. On the upper end knocking on the doors of some fundamental research and some baseline questions, having the bulk of activity around the applied science domain. And then an increasing percentage closer to the market end in pilots and demonstrators associated with the innovation portfolio. It is quite a large spectrum. The thing that we ensure is that wherever the project sits in that spectrum, it has a vector (direction it is moving in). So, it is not normative, it is actually pushed in the particular direction of the market. The only difference is in the magnitude of

the vector. The further upstream you are, the smaller is the magnitude of that vector. The close to market you are the larger the magnitude needs to be. The WRC has never done blue sky research.

The second thing is that we made investments in our Business Development and Innovation unit, which is the newest unit within the WRC, to very specifically mitigate risk in the market domain as far as we can. Some people argue that it is not within the mandate. My argument is that it is not within the old mandate. It is certainly part of the new mandate. The new mandate is about mitigating risk for upscaling on the one hand, but also to mitigate risk of investment that a pilot and a demonstrator and a technical assessment (and these are three different services that are now available from the WRC) has on the direct impact engaging a higher confidence in both the use of the solution, in an upscaled manner, as well as investments in that solution around commercialization.

Would you therefore say that uptake and impact fall within the ambit of the WRC's mandate?

Yes, it does.

The Plan also states: A paradigm switch is thus required to take research outputs into outcomes and impact for the broader society. What are research outcomes and how do they differ from research impact?

It is a time-based difference. A research impact is you do a research project in a particular place, and you finish on Wednesday and you examine what has been the change in state of play in a particular environment but measured the next Wednesday, and then two months after that and so on. That is impact.

Outcome is engaging whether or not there has been a substantive enough positive shift inside a system based on what you have done. Outcomes generally can't be measured immediately because there you are looking at the sustainability element.

As an example, the impact indicator of the work that we did on social innovation around sanitation janitor services is how many new companies were formed out of that intervention. The outcome indicator is how many of those companies are still around two years from now and have now started to change the way sanitation services are operated in this particular case in the school environment. The further outcome indicator is whether this becomes a dominant paradigm on the way it is done inside that system and the number of schools that are now covered inside it.

What do you regard as the best indicators that the WRC has delivered value for taxpayers' (water levy) money?

The indicators that are in our annual performance plan (APP) [See 2.8.4].

In terms of the best indicator, it would be dynamic in terms of when you are answering the question. Where you are sitting now, the thing that would jump up as a very big indicator of impact, is the current work that the WRC is doing on wastewater surveillance for COVID-19. So, it sets environmental indicators for wastewater that is proving quite pivotal and powerful as a predictor.

If you would have done the same study two years ago, in spite of how important that is, it might have been something different. So, it depends on that kind of vector.

General improvements in water access, in sanitation access, in markers for water quality, these all play out in that dynamic at any given point in time.

Alongside that is the work around empowering the system to operate. So, the WRC, as a performance indicator, says it is good for 400-500 postgrads in any given year. Now that is very

powerful, because the majority of the technical or professionals at the higher knowledge end of the system come from that cohort. Except it doesn't come immediately. Those people who are finishing Masters and PhDs and doing Postdocs in the system today, are either the research leaders or the head of utilities and laboratories in ten years from now. If you didn't have that, then this pipeline will disappear.

There are a variety of indicators. The Annual Performance Plans are worth a look at. Gives you the spectrum that we engage around outputs and outcomes.

Should the WRC indicators reflect how the organisation addresses topical issues?

The WRC puts out communication on a variety of things, it depends on whether or not people engage with the information and whether they read it. There are some stakeholders that are quite good at it. Unfortunately, the larger bulk of indicators don't and are very reactionary. That is around the state of the maturity of an environment.

There is the temptation as an institution to redirect your efforts into things that are the priorities and the thoughts of the day. For example, a couple of years ago, temporary job creation became a big indicator. We saw institutions around us cascading into that enterprise, redirecting a lot of their resources into creating temporary jobs. Some were rewarded very measurably. But it is not part of a sustainable
strategy.

Knowledge institutions have to know their place in the value chain and has to be sufficiently brave to hold their place in the value chain around ensuring the sustainability of the system. The ones that flip flop towards what is a priority in a particular point in time, will thrive in that time, but will have to catch up later. There are institutions around us that had to have major redirections just to recover their core capacities. Some very large institutions and some institutions that will never be able to (recover).

The WRC has a very considered view of this. A very dynamic view of this. In part a little bit ahead of many institutions around it in the way it carries that perspective. I'm speaking from the inside. From the outside we might be considered a very dumb organisation. We've been able to balance: you can't ignore what the need of the day is that would be foolish, but you got to engage the need of the day in a way that takes forward what your strategic enterprise is even if that is not the priority of the need of the day.

A modern-day example of that would be the graduate employment programme. The WRC engaged with the Presidency to say: "of course we agree that unemployed graduates are an absolute travesty". In fact, we have one of the biggest proposals operating in that domain via DSI, but all of those graduates that are recruited into the programme are organised to take forward WRC projects. So, the strategic core enterprise is in fact what they feed off on and they in turn contribute to. So we meet the targets of graduate employment, in fact very successfully, because the Presidency wants us to take another big chunk of that work, and we've added value to the core enterprise. To take the core enterprise further. And we have the possibility of those graduates that are part of the programme considering both water as their future trajectory and perhaps even water research, development, and innovation. I think the smart way comes around how you interweave those different aspects so that you have a strengthening of the vector of your strategic intent. I think the WRC in general does that very well.

Any areas where you feel the WRC can do more, or do things differently?

Yes of course, that is expressed in the Corporate Plan. The Corporate Plan is a five-year plan. In the current five-year plan (and this is subject to folk leading this in that direction at their discretion), the focus is firstly around organising a more formalized relationship with the market in the form of an innovations company. Where you have a vehicle that deals with the current cliff that you have exist between where something is being demonstrated and its uptake in the market. And the very big gap we have in manufacture, in localization. An innovation company concept is something that currently exists in the Corporate Plan to build that bridge in a very real way. It is engaging the innovation chasm in a material engagement way.

The second is to take up the level of this capacity building in the form of an academy concept in the WRC. We do very well in creating high levels of research capacity inside the system but what we don't have (despite the fact that we have a very large repository of knowledge) is a practitioner training base formally inside the WRC. We have many projects that do this, we've been working with many partners like SALGA around the masterclass for municipal water engineers. But we can do that in so many other domains. So, the second thing that we are looking at is around that valorisation in the form of an academy. The academy concept can go in many ways. At its most basic, it is using what the WRC has already learnt from its research, making that part of the material that is available for the procuring of a number of other kinds of practitioners. Maybe people like yourself to actually go do this training out there. I think that would be the majority model. But for some things that are very specialized and very specific domains, the WRC might pull it a lot closer, because we also have capacity in house to do that kind of training.

We have an interesting experiment currently because the WRC has put in a proposal to EPFL in Switzerland around developing a MOOC in the sanitation domain and that is a very good test point for the WRC because we are getting an external review now around the viability of this concept.

The thing that we can't answer concretely yet is whether this will be done majority in or majority out. But the thing that we are quite clear about is that it is definitely a partnership, because it needs a large number of players and a large number of institutions, maybe even new institutions and of course plenty new practitioners. We want to do this as part of the broader scope of the industrialization of water in the country.

The third domain is that water information and data is unfortunately very scarce inside the system. We tried to fill that gap in many ways by putting out projects and we have a nice practitioner base out there that assists with those projects in reasonable times as a community of practice to stimulate the Department in re-injecting some momentum into the Blue Drop and Green Drop to start. But the other Drops will follow. That is great, but it is starting to be anecdotal. What we need is a permanent real-time water observatory. One of the things that have been put into Minister Sisulu's performance plan (the new minister may change it) is the concept of a water observatory in the country. Have continuous monitoring, real time access to data, but frequent analytical depth in the form of perhaps annual or bi-annual reports. That takes the data and organises the data into a broader base narrative that becomes a collecting point in time in terms of the state of water inside the system. Dealing with water quantity, water quality, planning, groundwater, sanitation, no drop, water efficiency.

Keeping data updated (of WRC projects) will be part of this domain. It is a fundamental starting point for that because part of the problem (and we have corrected some of this) is that the data policy was very loose. No longer so. We are now quite clear that we already have the beginnings of the integration of data from individual projects into knowledge platforms in different domains inside the WRC. Some of it is easier to do and some of it is a lot more sophisticated to do, but that is work in progress. We are going to have to have a much bigger monitoring system. So, we have big ambitions

around organising for citizen science projects, around climate indicators, around organising for a drastic expansion in things like miniSASS, around first level water quality engagements. And then the whole thing about more formalized laboratory networks inside the system particularly servicing municipalities. One of the things we have done with SALGA is to set up the scientific services forum for municipalities. These are all building blocks in that domain. Operating a water system that is a scientific enterprise without good scientific indicators is very hard to do. This is the direction in which it is pushing.

There's a lot of territorial waters that the WRC will have to comb through. Much of it has already been raised by various players including DWS claiming spaces, but the system will get past that eventually.

The broader vision that currently exists in the WRC plan and in part in the Minister's performance agreement is to get the country as a whole, having its entire practitioner base, being supported by a very powerful water science system.

Those are three big things that the WRC has thought about already and is engaging in its new Corporate Plan. In fact, there are some indicators for this current financial year and for the next two around setting these up.

What value does the GWRC add to the work of the WRC?

The very nature of the GWRC membership is that you have enquiring organisations playing on the cutting edge of what is known in different domains (that is the core characteristic of all of us). That sharing happens very spontaneously in the GWRC. It is a great value add.

The citations from elsewhere have great power in the system. If you are addressing a South African audience, and you say this is the great thing that we did at the University of Cape Town, they would go: "that is interesting". But if you go to the same people and you say this is what I learned from Austria, everybody is listening because in the South African environment anyone that is not from here has to be better than us. These citations that we get from the global domain into the local domain is a very powerful value. Interestingly enough, what I said is true for the other countries as well. It says something about human beings: your backyard is never good enough.

There are many things that we can simply not do on our own. Our wastewater surveillance work in this country gained hugely from the fact that our partners in the GWRC are in fact leaders in their regions in the world. That is a great example of the power of this global collective.

While there may be many arguments in various other sectors, I don't think there is any argument that science is always a global enterprise, it is never a local one. You have local value adds to this global enterprise, but it always has to be a global enterprise.

Do you foresee the private sector (industrial, agricultural, etc.) engaging with the WRC on research needs?

We have a lot of that already. In our agricultural domain, which might be the most advanced, 70% of the projects are co-funded by the industry already. They are not shy about their contributions. Within that 70%, in most cases, more than 50% of the funding comes from the industry. That is a very direct injection of not only requests but also organising for contributions. These contributions don't include the fact that you need your laboratory to be out in field and we can't go and grow our own fields. We actually use the fields that come from those associations when we do the research.

A lot of that happens and it happens in a number of sectors. It happens very big in mining. There are many very powerful examples already of how that already operates in the most practical way.

And I would go further than that and say, without having tested it, that this makes the WRC very unique in that family of institutions that are the science councils where they actually have the very active partnership, not just at a conversational level, not just at the Reference Group level, but an actual financial contribution to make these things operate in a very powerful way.

You have to keep a fine balance, if the majority of your funding comes from particular sources, then those sources determine your entire agenda. We have examples in the GWRC of institutions in that space. Your funding base tells you what you should look at. They are not interested in things that do not have a direct impact on them. You should keep a majority share of your funding coming from a generic base like the water research levy that allows you to examine societal issues. If you don't have that then you become an association institution and by virtue of that mandate you have to do association work.

It is also fair to say if you go to the other end of the spectrum, if you have no injection from the practitioner base as a demand pool, there is a reasonable chance that a lot of your stuff sits in very smart reports in some knowledge hub on some database and gets used by a combination of academics and consultants. You have some level of an impact but then the distance between what you do and the market becomes much larger and the magnitude of that vector becomes much smaller. You got to smartly travel that road.

In the mining and agricultural sectors, there is a fair injection of players in leadership positions who themselves have come through the WRC system usually as students. Their intrinsic appreciation for some distance from the laboratory, respecting what the value of science as an independent opinion contributes to that, is part of the reason why it works.

You create these communities of practice in a very powerful way. You get multiple dividends out of it. One of the dividends comes to the WRC but the larger dividend is that companies can have continued connectivity to a research base that other people pay a lot to get. When you engage the WRC as a partner, you don't just get the WRC, you get a WRC network.

Innovation and Impact is a separate branch within the WRC. Why is Innovation and Impact separated from R&D?

That has to do with the very bureaucratic strategy around budget prioritization of different programmes. Although it was sitting in back burner as a very useful add-on to the WRC enterprise, until we were able to create a Business Development and Innovation unit, we couldn't get specific funded programmes into that space, and we couldn't buy the capacity that we needed inside that space.

Now what the future is going to look like is something that the WRC will have to work out, because it can be that you bring it to the kind of level where your innovation company concept takes over completely. It can be that you maintain that as a principal support structure, and you could have other variations of that. But I thought that the experiment served us very well. For example, everybody had a crap year last year and their performance indicators says so, but if you looked at the WRC's performance report for 2021 a couple of years ago from now, you would not guess that we were in the middle of a pandemic. Because firstly we met the indicators that were required, we were the only institution in the water sector that didn't submit an adjustment to the APP. We said no we are going to do it; our indicators say that we are going to do it. We did some very smart internal strategy to make that happen. Secondly, while everyone was demonstrating a decrease in their overall budget, and we had a decrease in our levy budget, our overall budget for the WRC actually increased last year. That would not have happened if we did not have a specialised unit around business development and innovation.

Dr Mandla Msibi, Group Executive: Innovation and Impact

Innovation and Impact is a separate branch within the WRC. Why is Innovation and Impact separated from Research and Development?

- For the first 40 years of the WRC, its mandate did not focus on delivering research-based solutions directly to water users (households, communities), but rather through intermediaries (DWS, municipalities, water boards, CMAs, etc.). The focus was on delivering value to intermediaries.
- Delivery of value depend on intermediaries and how well they perform their jobs. Observed in last 15 years, that some are experiencing challenges in performing their mandates. They lost capacity and were not in the position to receive or apply knowledge. There was therefore a visible gap.
- South Africa is facing water scarcity problems and the solutions are not reaching the end-users. The WRC therefore established the Innovation and Impact division to take research beyond the laboratory desk. Focus on specific phases of RDI: pilot, upscaling and commercialisation.
- The division focuses on impact stories and taking solutions to where they can be applied.

What does your division do to facilitate innovation and impact?

- The division has a close working relationship with Research and Development.
- The division does the following:
    - Identifies projects that have the potential to make a difference, especially in terms of saving water and using water that would not otherwise been considered (new water sources).
    - Works with partners to fund projects, water research levy is not enough.
    - Also, takes on partners where new technologies can be piloted (test beds in municipalities for example) and rolled-out.
    - Focuses on taking solutions to the field and rolling out in schools and communities.
    - Negotiates with people who can commercialise it. Have a fully equipped unit for Intellectual Property (IP).
    - Develops own solutions especially in terms of sanitation with the focus being on dry sanitation solutions to save water. At the moment, 15 different types of technologies are being tested in the field.
- Current challenge is talking to investors. Need a separate wing or unit to deal with negotiations between innovators, government and investors. The WRC is considering establishing an innovations company unit. They also want to take on National Treasury as a partner.
- Consultants are very powerful, but they have to be careful when targeting them. Could be interpreted as the WRC empowering consultants.

What are your most successful actions? What are your least successful actions?

- Most successful: Technology is developed through a formal research network. Good innovations are unearthed and taken from desktop to application. Measure success in how many projects can be taken to that level.
- Least successful:
    - Partnerships and negotiations.

- Not great at commercialization. Actual take up on commercial side is not satisfactory. Municipalities are sometimes reluctant to take risks with new technologies.
- Must better facilitate impact and tell the impact story in a consistent way. New strategy will focus on this. What benefit/value are we deriving from the water sector? Tell the story. There's a lot to be told.

What are the performance indicators of your division, Innovation and Impact?

- Measure how effective we are engaging with society. Number of agreements and partnerships established (counting approach). Internally it is more about quality. Reduce partnerships and focus on those at top.
- Look at technological levels. Number of technologies taken to the next level. Also, IP reports (counting approach). There has been none that have directly indicated impact.
- Demonstratable impact is very important. Engage with communities on something that is demonstratable. Tell impact story: capture before and after with pictures, videos and voices.

What is your biggest challenge in meeting your performance indicators?

- Structuring of indicators, current indicators are technical (counting approach). We meet the indicators but do these indicators demonstrate the impact/benefit?
- What would qualitative indicators look like?

Dr Valerie Naidoo, Executive Manager: Business Development and Innovation

From the WRC's perspective, when would you call a WRC research project a success? Is there a difference between a successful project and a project that has delivered value to the WRC?

- When the project meets the objectives set in the proposal it achieves a certain level of success.
- Value is when you are able to change something in the sector: take product (tool, skillset, etc.), identify where it fits into the sector and scale it up in way that resonates with the intended market. To only give guidance/recommendations does not give value across the board.
- Potential value is more relevant in the research world. Value in true sense is a transaction.

From the perspective of the WRC, is ''value'' and ''uptake and impact'' the same thing?

- Value:
  - Depends on mindset. You get different types of value, for example academic value, scientific value.
  - In the WRC setting (using levy funds), value is when you take WRC research and apply it. Taking WRC research and creating products or services that bring about change.
- Impact:
  - Difficult to go all the way to impact but can tell some of the story. What change has the innovation (product/service) made? Focus on the triple bottom line.
  - Deliver impact by listening and understanding what people want.
- Technology transfer: technology is not the final report. Need to take a more deliberate approach. Relook at the process and ask: is the research product enough? Create a prototype and test it at scale. Take age gap, gap in education, capacity, etc. into account.

- Uptake:
    - Is a market discussion. Need real understanding of partnership model. Straddle the stakeholder and partnership space. Don't stay narrow, don't think small. Dream big.
    - Fact that South Africa has physical, capacity and budget constrains calls for more innovation. WRC is taking more time to matchmake and get the right technology to municipalities for example.
    - Communities must be part of decision making. Need long-term engagement process with communities for societal change.

What are the indicators that demonstrate that the WRC supports or facilitates uptake and impact of RDI projects?

a. In terms of the research environment:
- Strategic areas WRC is driving.
- Student involvement in research projects.

b. In terms of the proposal and reviewing process:
- Proposal template design has strong focus on uptake and impact.
- During review process, usability and possible impact is questioned.

c. In terms of the project roll out:
- Reference group mechanism.
- Researchers must engage communities: include engagement and consultation process in project, or a social scientist in a technical project.
- WRC can facilitate discussions with municipalities.
- Make people aware in contracting process of POPI, acting ethically and appropriately. If you have a bad reputation, you will not get uptake.

d. In terms of taking the knowledge into implementation beyond the project end date:
- Technology accelerators like the Water Technologies Demonstration Programme (WADER).
- Build trust with partners.
- Innovation reports and IP due diligence.

How would you measure these indicators?

- APP targets
- Academic indicators (publications, citations, etc.)
- Measure exchange activities (must resonate with intended users)
- Number of demonstrations and innovations
- IP due diligence
- Leverage partnerships
- Spending as reflection of relationship with partners
- Upward trend in students.

Any areas where you feel the WRC can do more, or do things differently?

- Can always do more, but also depends on internal capacity and quality of personnel.
- The Innovation and Impact branch has an open-door policy, open to broader engagement with researchers. This message needs to be reinforced more.

Research partners

Department of Water and Sanitation official 1

When did you first hear about the WRC and how have you been involved in WRC research?

- Can't remember first contact with the WRC. Was in the early 2000s.
- Personal involvement started 4 years ago, mainly through sanitation projects.
- Had bilateral meetings on a quarterly basis to ensure that DWS is aware of what the WRC is offering and that there is uptake. The WRC shared information on projects and in some cases DWS had the opportunity to influence their research agenda. This gave DWS the opportunity to work more closely with the WRC.

How would you describe the role and mandate of the WRC?

- The WRC identifies what is happening globally and where we don't have the answers. They engage with DWS in terms of priorities and also gauges the Department's research needs.
- The DDG: Planning and Information has identified a champion. A central point of contact for the WRC. This will strengthen the relationship between DWS and the WRC, and better coordinate inputs in terms of research needs.
- Sometimes the WRC engages haphazardly with whoever they know for Reference Groups. This might not be the right person to put on the project. The champion will be able to direct the WRC the best suited person(s). It is important that the right people are targeted for projects.

From your perspective, which WRC project, or projects, has had the most value for DWS?

- Study to improve the water and sanitation questions on the Census and General Household Survey questionnaires: Important study because DWS uses Statistics South Africa (StatsSA) information for planning and decisions. StatsSA has not yet implemented the recommendations, but the official hopes that the research will change the way information is collected in future.
- SASTEP programme:
    - Developed in partnership with DSI (funded by the Bill and Melinda Gates Foundation).
    - Gives innovators the opportunity to showcase their sanitation technologies. Especially technology that minimises the use of water (dry sanitation solution).
    - Municipalities are often hesitant to use new technologies and innovation. They are uncomfortable to take risks. This programme follows a standardised, transparent process to assess, validate and certify new sanitation technologies. This gives municipalities the assurance that the technology has gone through a rigorous process and has been endorsed by DWS.

From your perspective, which WRC project delivered less value than DWS expected?

- Shit flow diagram project:
    - Eight WSAs were involved, but the Project Team did not actively involve DWS in the project. We only read the reports.
    - It would have been easier to take up the recommendations if DWS was more involved in the process (i.e. talking to the municipalities).

What can the WRC do to deliver more value to DWS?

- Ensure DWS is more actively involved in projects. Easier to take up recommendations in a project you have been involved in.
- Continue to get input from DWS in terms of research needs and priorities. Make sure that they are responding to DWS's needs.
- Ensure right people are on the Reference Groups: people that will use the recommendations and who are implementing agents within the Department.
- Allow DWS to take ownership of research: ask for input more often and to check if researchers are on the right track in terms of DWS's needs.
- More research on:
    - Waterless/no water technologies
    - Decision support tools for municipalities, such as decision-making matrix to help municipalities select the best sanitation technology suited for a certain settlement type.
    - Guidance on economic and practical benefits of sanitation value chain.
- Will have a bigger impact if we plan together: Involve DWS in strategic planning and vice versa. We have access to the WRC's Annual Performance Plan but it is very high level.
- Take DWS on board at all stages of project.
- Knowledge exchange: WRC has improved a lot in terms of their knowledge exchange. Used to be a weak area.
- Important to target the right branches with the right projects.
- Partner in deliberations with EWSETA.

Department of Water and Sanitation official 2

When did you first hear about the WRC and how have you been involved in WRC research?

- The official's first contact with the WRC was informal brainstorming sessions with Dr Gerhard Offringa twice a year. This gave him the opportunity to inform the WRC's research programmes. He also became more formally involved in the WRC's work.
- Personally, benefitted from relationship: The WRC assisted the official in gaining credibility, also on the international stage. He represented South Africa on the WHO's platform for regulation and has travelled to many countries to discuss different topics of WRC research.

Would you say that the WRC is the first port of call when the Department is looking for a water or sanitation research-based solution?

- Yes certainly, but we could use the WRC more.
- Work in a sector where private sector partnerships are used a lot. The WRC should be the most competitive of all and rather partner with the private sector than compete against them. The WRC could play a bigger role in harnessing talents and skills (those doing Masters and PhDs).

Which partnership role would you say delivers the most value to DWS?

- All partnership roles are valuable.
- The procurement process of the Department has been lacking since 2015, it has therefore been helpful to have the WRC as implementing agent to assist with a credible procurement process.

- Reference Groups offer capacity building opportunities. To feel you are relevant and that your expertise is needed. This gives value and employee satisfaction to officials. And provides them with learning opportunities.
- The official believes that DWS can use their learning academy structure to give young graduates the opportunity to participate in Reference Groups.
- The official noted that some things are influenced and implemented by the WRC and not the Department. For example, the guide on the assessment of wastewater treatment plants. The work has already been done and DWS can take the guide and put it into effect. There is value in DWS not always being the leader but also an implementer and partner.

From your perspective, which WRC project, or projects, has had the most value for DWS?

- The dam siltation management project with Dr Shafick Adams and Ms Sharon Coetzee. It started out as a Council for Scientific and Industrial Research (CSIR) project, but realised we were not getting what we want. Took the project to the WRC where a diverse group of people came together to debate and influence strategy. The WRC's viewpoint is fair and not biased.
- The WRC has done a lot of work in the sanitation space looking for on-site solutions.

From your perspective, which WRC project delivered less value than DWS expected?

- Cannot recall a specific project.

What can the WRC do to deliver more value to DWS?

- Shorten project cycle for specific projects to better facilitate uptake.

What can the WRC do to make DWS officials more aware of its work and the potential value that it has for DWS so that they actually use this knowledge?

- He hopes DWS can better institutionalize its relationships with the WRC (especially the Planning unit and the units working on climate change). There is also room for improving the awareness of the WRC within the Department and involving the WRC in the day-to-day operations of DWS.
- Join hands with DWS's learning academy: It is important to provide graduates with opportunities to be part of projects and to make them aware of upcoming webinars.
- He suggested that the WRC appoints someone to act as a liaison officer within DWS. A "double agent" at management level that brings the two organisations together.

Department of Science and Innovation (DSI)

What are the different roles in which DSI partner with the WRC?

- The key role of DSI at strategic level was to commission and fund the development of the WRC RDI, which became the key driver of the WRC strategy. DSI remains in the role of having oversight to the RDI and ensure that the RDI is used to catalyst new projects and sector partners. The reason why DSI supported RDI was that they observed that various pockets of excellence existed in South Africa, and the RDI brought it together and made it more coherent.
- The second main programme supported by DSI was to develop and fund WADER.
- DSI appreciate the unique position and role of WRC as being a Research Funder, not a Research Institution – research is outsourced to experts in different portfolios, with the WRC

responsible for quality control. The one bias mentioned is that the WRC Research Managers has a bias towards their own interest fields.

When would you say a WRC research project has delivered value to DSI?

- RDI Roadmap and WADER are managed by Ms Shanna Nienaber and Dr Manjusha Sunil respectively, on a programmatic level. The value is that WRC has taken on the RDI Roadmap as strategy, and WADER is funded with a R45m grant to develop and roll-out disruptive technologies.
- The WADER programme is not where DSI would have like to see it at this stage. Although the concept, funding and structure is solid, the technologies are not reaching the marketplace. In future, WADER will need to engage investors more actively, and need to partner with the Technology Innovation Agency (TIA) (DSI entity), as TIA has been designed to get innovators to the market. TIA has, however, not succeeded in this mandate due to various internal reasons.
- DSI is not seeing how the outputs of WADER are influencing policy on national level. Plenty good reports are being developed and shelved, but not used by decision-makers.
- DSI hopes that with new WRC leadership, the transition phase will benefit the uptake of WADER projects. DSI notes that other countries see the value of the WRC outputs, but not equally appreciated or taken up in South Africa. There is a possible future role for DSI in policy, especially engaging DWS on a policy and strategic level.
- DSI encouraged to note that the DWS Green / Blue Drop regulatory programme have been resuscitated, as they serve a valuable purpose to identify innovation opportunities in water and wastewater management.
- DSI considers it important to build a water economy – by getting the right people and attitudes together. The Phakisa later this year would be important, but ''we need to make a change and have specific timelines to achieve set objectives''.

Are there some partnership roles that deliver more value to DSI than others?

- WRC value is in its reputation in the South African and international water sector. The sector does not know DSI in the water space, so DSI chose WRC for its reputation and ability to get things done.

From your perspective, which WRC project, or projects, has delivered the most value for DSI?

- The South African Sanitation Technology Enterprise Programme (SASTEP) programme, it is DSI-funded and has the Bill and Melinda Gates Foundation as partner (agreement in place). The WRC signs the agreements with international partners and is the face of SASTEP.

Which WRC project has delivered the most value for you personally?

- The Living Catchment Project has produced the highest value. It was started in 2013/14 by the official and Ms Shanna Nienaber and has matured, expended and broadened in the meantime. The complementary thinking within the team, with Mr Christo Maree, looking at the Mzimvubu catchment, and working with South African National Biodiversity Institute (SANBI), have opened new views and approaches to ecological infrastructure and water security. It started as a small R200 000 project and is now R1m/year. DSI funds the project with WRC and SANBI as implementing partners.
- Allowed official to grow in this space – he is a technical person but has learnt the value of a multi-disciplinary approach, which include social scientists.

- The project is now gaining traction and evolving to overcome political hurdles by engaging on presidential level. The project team is targeting strategic water sensitive areas, and this approach holds significant potential for improvement in various catchments.
- The team is also working with the University of Sussex, which offers additional expertise to the project.
- An ecological infrastructure indaba was born from this project.

From your perspective, which WRC project delivered less value than DSI expected? Why?

- WADER did not deliver to expectation, as previous noted. This programme has not yet realised on its journey of discovery. Again, the value of social science comes to the fore. Suggestion to do a poster, showing the lesson from both academic eye, and practical and market perspective.
- One of the hindrances is that the water sector does not want to change. We need to break this resistance to change if we want to be a water secure country. The role of DWS is critical, they need to be nimbler.

What can the WRC do to deliver more value to DSI?

- We need to work harder to influence DWS, to give advice and take advice, work under less tension. The new leadership may bring new opportunities, which may open more value to DWS and to influence their thinking.
- DWS is however, acknowledged for the development of the Water and Sanitation Masterplan. This is essential to inform policy makers.
- We have a lot of evidence-based research in South Africa, but it is still not translating to policy.

Are there areas in which you think the WRC can or should do more research?

- WRC should look at research outputs and get more traction. There are many crises and challenges in the water sector, we need to use the evidence to implement the solutions. When a crisis emerges, we do not see that the WRC solutions are emerging. WRC has a significant knowledge repository, but the uptake is poor. Research is needed as to why this is not happening.

Is there any way in which you would like to see DSI's partnership with WRC expanded?

- As previously explained, DSI plus DWS' Director of Sanitation need to move into the strategic and policy space and start influencing policy. Problems need to be identified and research grants need to address specific gaps and policy and strategy. The foundation is ready for the WRC to do this. The advantages would be a better voice and equilibrium to bias (why we don't see change). DSI in a position to manage the systems, science, councillors, etc.

We have in South Africa a research institution that focuses on water and sanitation research. Yet, the Technology Innovation Agency does not have a specific focus on water or sanitation. Do you think this is a missed opportunity?

- TIA has a water and environmental resource section. Agrees this is indeed a missed opportunity. WRC and TIA have been unable to find a way to work together.
- WADER is one example. More than 30 innovations, but not taken up by TIA – this is a missed opportunity. TIA does not have the necessary expertise in-house. A partnership between TIA and WADER would have been important to access the market opportunities and build viable business cases.

Closing comments

- The main value that WRC brings to the system is its reputation and institutional standing. WRC is an important player in the eco-system. However, they need to find a way to influence the 'system' better.
- One way to do this, is for the WRC to identify critical individuals and levers in the system and connect with them.

SALGA

SALGA's relationship with the WRC: How did it start? How did it develop?

- Dates back over 10 years. Was introduced to the WRC through Ms Bev Pretorius. Managed to secure a meeting with Mr Jay Bhagwan to discuss municipal benchmarking.
- Relationship developed incrementally. Very sound, professional relationship, but needs to be taken further. Official had a good discussion with the WRC on how to collaborate on programmes of mutual interest. Led to signing of a Memorandum of Understanding (MoU).

How do you communicate your research needs with the WRC?

- Submit research needs when WRC requests them to do so. SALGA forwards request to municipalities and ask them to submit topics. Follows a targeted approach: some municipalities (or individuals representing municipalities) will respond, others won't. Response is not great. Official has observed that some municipalities do not understand what the WRC is or what they are trying to do. SALGA is the last line of defence; they understand what some of the topical issues are for municipalities. Send them through to the WRC.
- Recently worked with the WRC to launch a Technology and Innovations Forum (September 2020). Forum members can influence the WRC's research agenda. This is a more structured way for SALGA to communicate their research needs.
- Both organisations have local and international partners. Try to compare notes to ensure there is no duplication of efforts. No structured way of sharing partnerships.

The WRC's project time frame is usually more than 12 months. Is that a problem for SALGA?

- Double edged sword: Want to respect WRC's internal processes but also want to influence inefficiencies. Don't know how projects are awarded. If SALGA understands process better, they would be able to better influence it.
- Recommends flexible project cycle: certain types of projects take longer than others.

What are the different roles in which SALGA partner with the WRC?

- Partner, collaborator, funder and also solution seeker.
- Play critical role in Reference Groups: opportunity to participate in research journey and shape outcomes.
- Co-funded number of projects, such as the perception and benchmarking studies.
- Thoughts on including intended beneficiaries (in this case municipalities) on Project Team:
    - Must consider referee vs player. Want element of impartiality. If they are part of research, they might influence it in their favour. Time might also be a problem.
    - Could perhaps include municipal interns or graduates to build capacity and enrich their career development.

What do you expect from a WRC project that SALGA funds or co-funds?

- Each organisation has their own vision, mission and strategic plans. At bare minimum expects the WRC to deliver on their mandate.
- Important to agree upfront what they need to do collectively: what are the problems that need to be resolved?
- Would be good if the WRC invites them to some strategic planning sessions so that SALGA knows upfront what the WRC is trying to achieve.

What is the value that the WRC delivers to SALGA?

- Evidence-based research.
- Implemented research (taken forward through certain mechanisms), e.g. Hydropower research implemented at Bloemwater is word class.
- Wealth of knowledge: WRC has an international footprint and procures world class people to lead projects.
- The WRC has their own Annual Performance Plans and they communicate progress on them, but the sector has not agreed on indicators on how to measure the WRC's performance.
- Translating projects into uptake is always a challenge. Not seeing uptake because the WRC tries to do everything (including implementation) by themselves. It is not the WRC's mandate to do everything. Need to pass the baton at some point to other partners. Said to the WRC: Give the headache of implementation to others, but don't walk away.
- Admitted that SALGA also struggles with uptake. Procurement is a big hurdle.
- The Technology and Innovations Forum will approach National Treasury to negotiate innovative procurement solutions for example a different procurement process for innovations developed from WRC research. Also, in process of signing a MoU with Consulting Engineers South Africa (CESA).

From your perspective, which WRC project has delivered the most value for SALGA? Why?

- Projects that were collectively conceptualise and defined. For example, the benchmarking project delivered value even though they ran out of money.
- Working together on the COVID-19 surveillance project.
- Jointly conceptualised SASTEP, WADER and the Technology and Innovations Forum.

From your perspective, which WRC project delivered less value than SALGA expected? Why?

- Projects that are not implemented or taken up deliver less value/Return on Investment.

What can the WRC do to deliver more value to SALGA?

- Adopt a bottoms-up approach to place emphasis on uptake.
- Bulk of WRC's revenue is from municipalities. The WRC should be biased and deliver value in terms of their revenue. Target those groups first. The bulk of difficulties also sits in that space.
- System should be flexible enough to accept proposals outside formal structures.
- Promote partnerships and allow partners to take ownership.
- Must have a good understand of how the system works to promote uptake and impact.
- Involve end-users earlier and higher up in the conceptual process.
- Focus on projects that will be of national importance.
- Look for funding partners in public or private sector.

Higher Education institutions

An online interview was conducted with a representative of the University of Stellenbosch, who also served on the Board of the WRC.

When would you say a WRC research project has delivered value to the US specifically? And to a higher education institution in general?

- The research partnership that the US has with the WRC has developed over many years. The value of water research is a topic that has been researched at the university. See Nico Elema's recent PhD thesis: *The contribution of the Water Research Fund for Southern Africa (WARFSA) to knowledge production and policy in the SADC water sector (Elema, 2019).*
- The value criteria that WRC research has to meet to deliver value:
    - Capacity built: There is an enormous shortage of high-end skills in the water sector. We measure progress in this regard in terms of the number of postgraduate qualifications; and the number of patents registered.
    - Impact:
        - Economic: publications in peer-reviewed journals and even more important, citations; the employment positions in which these post students are making their contribution
        - Innovation: number of commercialised patents
        - Ecological: for example, successful treatment of acid mine water
        - Financial: for example, job creation

  A (WRC) research project must meet at least three of these criteria to be deemed successful.

Is there any specific WRC project, or projects, that has delivered exceptional value for the University of Stellenbosch? Why do you say so?

- Difficult to pinpoint a specific project because WRC projects span different faculties and institutions, for example Engineering, the Water Institute, Natural Sciences and Agricultural Sciences. Would therefore give a few examples.
    - Decentralised water provision: Domestic rainwater harvesting and solar water disinfection or SODIS (Professor Cloete and Prof Wesaal Khan's research; a number of Masters and PHD studies, and publications); SA has become a world leader in this field. Enormous potential to be upscaled; there is already a roll-out strategy.
    - Berg River project done by the Water Institute (Prof Willem de Klerk's work on the impact of vegetation on river flow and the impact of runoff on silting.)
    - The SETAs training programmes in which the WRC is also involved
    - The NEPAD Water Centres of Excellence[22] in which the WRC is also involved
- WRC projects have all had significant impact:
    - Large number of postgraduate students
    - Publications
    - Interesting and stimulating topics
    - Research with practical application. This has always been one of the WRC's strengths.
    - Topics high on national agenda (high profile potential for researchers and US)

[22] The network of NEPAD Water Centres of Excellence (NEPAD Water CoE) is a network of Higher Education- and Research institutions who conduct high-end scientific research on water and related sectors, in order to provide policy guidelines to governments. http://nepadwatercoe.org/about-us/

- The WRC is structured to fast-track technology transfer via its Reference Group structure (which is also an excellent mechanism to monitor and manage quality) and the publication of research reports, guidelines, briefs, etc. The NRF is not doing as well in this regard.

What can the WRC do to deliver more value to the University of Stellenbosch specifically, and to higher education institutions in general?

- The WRC is doing excellent work.
- Establish one or more Centres of Excellence in water research to coordinate water researchers' work and interaction. Currently, universities tend to work in silos. WISA is not structured to play such a role. It is an instrument with powerful impact potential. (There are such Centres for Centres, for example, for renewable energy and alien vegetation) There could also be more than one Centre of Excellence for water research. For example, a Northern one for the Northern high education institutions and a Southern one.
    - Such a Centre (s) could be established in collaboration with DSI and DWS, with the WRC playing the coordinating role.
    - Functions: facilitate knowledge transfer and synergies between universities; outreach to communities; capacity building through postgraduate studies; cooperation between universities in the water and sanitation fields; building networks in Africa, for example through the African Research Universities Alliance (ARUA).

Are there areas in which you think the WRC can or should do more research?

- The concept of decentralising water supply
- Utilising wastewater as a resource (with associated business opportunities) as a solution to dysfunctional wastewater treatment plants. ''We need only one success story and the others will follow.''
- Innovative ways in which the country can deal with water crises associated with climate change.

Is there any way in which you would like to see the University's partnership with the WRC expanded?

- The WRC needs to identify who are the leading water and sanitation researchers in this country and they must look after/nurture them, making sure they are taking the lead in WRC research.
- The WRC also needs to identify the potential future research leaders and make sure that they are involved in projects and mentored as necessary.
- Centre(s) of Excellence is important to facilitate and coordinate the above.

From his perspective as a former member of the WRC Board, the respondent made the following observations:

In terms of its objectives as set out in the Water Research Act 34 of 1971, and as amended, what is your interpretation of the value that the WRC should deliver to its stakeholders in general? And, what would be key indicators that the WRC is delivering this value?

- For many years, the WRC's relationship with the Ministry was not optimal. This will hopefully change.

- The WRC has to demonstrate that it is an asset for the country that has developed world-class technologies to solve the countries current and future water and sanitation challenges. It could do so by:
    - Quantifying the challenges and their projected impact on, for example health (childhood deaths linked to waterborne diseases) or education (school days missed as a result of water-related diarrhoea, inadequate school sanitation for girls)
    - Showcasing the knowledge generated and technologies developed as part of WRC projects.
    - Developing in collaboration with government the necessary strategies to use this knowledge and technologies to address the challenges in the short, medium, and long term.
- The indictors of progress in addressing these challenges are easy to define and measure.

How do you understand the term ''stakeholder compact'' as it appears in the Amendment Bill of 2013?

- An agreement to align the WRC's research strategy with the research needs of its partners.
- Important to clarify who these research partners are the Ministry, DSI, DWS, NRF, NACCI, the Business Development Corporation, the utilities (Water Boards), the ARC, the CSIR.

Several research partners of the WRC mentioned in the interviews that they expect the WRC to deliver world-class quality research. Your view on this expectation? Is the WRC structured and managed to meet this expectation? Where could they improve?

- The WRC's research model is unique and this has contributed to its international status.
- The WRC has built its international reputation through Water SA, which is a peer-reviewed journal – their review panels are very critical.
- At some point, Water SA was the journal with the highest citation impact factor in South Africa. The WRC should consider making Water SA an open research journal as this is the trend and it would give the journal more citations.
- The NRF has a better model to coordinate research.
- In an independent review of the WRC which took place about two years ago, several stakeholders expressed concern that the new research managers were administrators, lacking the skills of research specialists. The WRC reasoned that he Reference Group should play that role. However, there is an upcoming new generation of black research specialists whom the WRC could appoint as research managers. Better cooperation with the universities would make sure that these specialists see and apply for WRC posts.
- A mentorship programme would also ensure that the skills of retired research managers are transferred to the new generation.

Several leaders of WRC projects mentioned that the WRC's fee structure is not in line with market rates and that this would in the long run discourage top researchers to undertake WRC research. Your view on this?

- Yes, the WRC has many relatively small projects. The organisation is limited by its available budget.
- There is a need for larger-scale projects. For these, the WRC will have to look towards supplementary funding from organisations like the World Bank, the Gates Foundation, etc.
- This takes resources and effort. For example, the University of Stellenbosch has a whole multidisciplinary team to access funding from Horizon Europe. The money is available, but it needs to be leveraged.

- The proposed Centres of Excellence could be instrumental in leveraging additional funding for water research. The NRF makes approximately R10m available to Centres of Excellence. The average amount of additional funding that these Centres leverage is five times this amount. Example of CANSA: the organisation had the same problem of a limited budget as the WRC. The solution was to change its approach. Today, they expect universities to leverage funding to cover 25% of the cost of cancer research themselves.

From what we heard from stakeholders, the WRC might have to compete with the private sector and parastatals like the CSIR for government water research projects in South Africa? Do you think this is a positive development? How should the WRC position itself to be able to compete with the major consulting companies?

- It is a positive development. *I have no problem with such a business model. On the contrary, I think it will be good for the WRC.*
- The problem is so enormous that government needs the best expertise it can get. This is to the advantage of the WRC in a competitive situation.
- How do you do it? You will have to sell your expertise. In other words, the WRC will be competitive if it has the best water and sanitation researchers in the country in its research teams. As said before, it is critical that the WRC identifies who are the world-class researchers in each field and get them involved and included in its research projects.

Water boards

The research team attempted to contact representatives from Umgeni Water, Bloemwater and Rand Water, but was not successful in scheduling an online interview with either of them.

The interviews with Reference Group members included an interview with a representative from Umgeni Water. The SALGA representative mentioned Umgeni Water, and this representative specifically, as instrumental in the establishment of the Innovation and Technology Forum.

APPENDIX C:
FIRST ROUND OF STAKEHOLDER RESEARCH: CASE STUDIES

Project 1: WATCOST

Overview

This project developed a user-friendly Excel-based costing model, called WATCOST, for estimating the cost of drinking water supply systems (Swartz et al., 2013). The model allows users to compare the cost of different water treatment and supply options being considered for a water supply scheme. In addition, users can create costing reports for existing water treatment systems, which assists with budgeting and asset management processes. It estimates the cost for all stages of the drinking water supply process from the base supply, water treatment, and water storage, through to the distribution of drinking water.

The WATCOST model can be downloaded free of charge from the WRC's Knowledge Hub. The electronic copy of the model contains the following:

- User instructions
- Input component (where the user will enter required information)
- Software that will do the cost calculations (model component)
- Output component (that will provide the tables and graphic costing results), and
- Database of costing information (not accessible to the user, only for doing cost calculations).

The manual is intended for use by decision-makers, consultants, engineers, planners, water supply authorities, and DWS to estimate costs of new water supply systems, costs for upgrading or refurbishing existing systems, and also to determine approximate value of existing water supply and water treatment assets.

The perspective of the Research Manager

Dr Jo Burgess was the Research Manager of this project. She is no longer with the WRC.

What is value?

- When the project has a knock-on effect. Many projects conclude with recommendations. If the recommendations are taken up and acted upon, the project could be considered a success. Some projects might have to be developed further, for example to develop a new technology or apply a business model.
- When the WRC finalises a project, its contract with the Project Team ends. But many indicators of success only come later in time. The Research Manager can make some inferences in terms of future impact, for example conference papers accepted, publications or articles drafted/accepted. This is what the Research Manager is required to count at finalisation stage.

What are the best indicators that the WRC has delivered value for taxpayers' money (water levy)?

- How well South African research does, and dominates, on international platforms.
- Considered to have good quality research and engineering.
- Number of experts in applications of research.
- Strength of water industry: perception that it is technically competent.

- Contribution of WRC researchers in peer-reviewed water research.
- Number of guidelines that get gazetted.
- Mine water research:
    - South Africans have strong presence at international conferences (25%)
    - From fundamental and new research to case studies (TRL 1 to 9).
- Also, a high standing in water re-use, smart agricultural and water efficiency research. As well regulation and policies.
- In municipal space: weak performance in water treatment and wastewater treatment are not indicators of weak research, but rather reflective of weakness of sector to apply and maintain knowledge.
- Must do a 360-degree organisational appraisal:
    - What is the WRC's international reputation?
    - Is the WRC invited to plenaries?
    - Does the WRC have a working relationship with other leader organisations?
    - Is the WRC playing with the global players?

Who are the intended beneficiaries of the WATCOST project?

- Helps municipalities, utilities, water boards and consulting engineers make cost effective decisions: connect small, shattered communities to an existing plant or put up a new plant to service the community.
- Communities are therefore the ultimate beneficiaries.

Did the project create value?

- Yes, she knows Overberg LM has used the tool. However, it is not easy to track the use of the tool. The WRC has no way of tracking how many people has downloaded (or used) it.
- She recommended the tool to a Belgian water services company, called De Watergroep. They were looking for a tool to help them predict the cost to decentralize their water facilities. They had to localize the tool and put in their own standard charges but found it very user friendly. The user guide explains how to update the model.
- The Project Leader marketed the tool at a WISA workshop (2014) and at the Municipal water quality conference in Sun City (2013).
- GreenCape featured the model on their website.

What could the Project Team have done to improve uptake and impact for the intended beneficiaries?

- Articles in trade magazines like IMESA. The kind of stuff municipal officials will read. Or in the SAICE, Engineering News and IMIE SA magazine to target engineers.

What could the WRC do to deliver more value (improve uptake and impact)?

- For this project: Trade magazine articles or a technical brief.
- In general:
    - Mechanism to track what has happened to a project
    - Website to track downloads and use.

What is the value that this project had for the WRC?

- Good to know that at least one municipality is using it. A WRC project is supposed to make things better.

- The Project Leader probably used it in his own consulting services to the benefit of his clients.
- The students involved in the project benefitted.

As a Research Manager, how do you ensure that the knowledge that your projects produce is taken up by the intended beneficiaries?

- Reference Groups:
    - Composition is very important. Must include relevant regulator, academics and the intended end-users.
    - Must keep the Reference Group informed from review of proposal to the end of the project.
    - Active participation is important: set meeting moths in advance, send documents early, send reminders.
- Informal mechanism: Encourage end users to share information with peers and with other groups.
- Throughout project, write articles for trade magazines and reports for DWS's bluescreen.
- Discuss knowledge exchange activities with Project Leader early on and identify where gaps need to be filled.
- Some knowledge exchange activities are the WRC's job, for example to re-package information to target different groups.
- Consider who the Project Leader is. Academics might need more help with knowledge exchange activities than consultants. The message and the messenger are important.

The perspective of the Project Leader

The Project Leader is a consulting engineer who has his own company.

In general, what is value of WRC research?

- Stimulating work, opportunity to be creative.
- Provides an income (not main reason for doing projects).
- WRC project can lead to spin-off engineering projects.

What value did this project have for the intended beneficiaries?

- The intended beneficiaries were municipalities and consulting engineers.
- Unfortunately, there is no mechanism to track downloads or use of the model.

Did the knowledge exchange activities add value?

- Presented the model at a WISA workshop and conference in Sun City. He does not know what the impact of these activities were. There is now mechanism to measure how well WRC projects are implemented.

Did the project build any capacity?

- Yes, a student from the University of Stellenbosch was involved in the project.

What are the indicators of uptake and impact?

- Calculate R&D as a percentage of GDP.
- Get feedback from users.

What was the value for you personally?

- Valuable learning experience: learned more about cost structures.

What could the WRC have done to improve value for you and your company?

- A mechanism to regularly update the model.
- More support with knowledge exchange activities.

What could the WRC have done to facilitate better uptake and impact?

- General comments:
    - The WRC is doing a great job in terms of identifying research needs.
    - It is a pity that the WRC sometimes asks you to cut your budget and scale down on a project.
- General recommendations for better uptake:
    - Mechanism to manage the pool of models and tools developed as part of WRC projects.
    - Include the main stakeholder in the research to allow them to take better ownership of the project's recommendations.
    - Re-package information to suit the needs of different target groups.

The perspective of a Reference Group member

The Reference Group member is from Umgeni Water.

In general, what value does the Reference Group contribute to a project?

- Assist the Project Team and steer research. Has to be applied research, otherwise it just sits on a desk.
- Make sure Project Team sticks to objectives.
- Provide industry knowledge especially if Project Leader is an academic.

What was your contribution?

- Insights into the costing of engineering projects.

What was the value for you personally?

- Learning experience: got information from other Reference Group members that he did not have before.
- Satisfying to see learnings take place, for example Masters and PhD students absorbing and applying knowledge that you have given them.

What value did the project have for Umgeni Water?

- Used WATCOST to calculate cost for desalination projects and small treatment plants.
- Value is not always measured financially. Value comes with time and the sharing of knowledge. Many WRC guidelines are well-known and have become key reference documents for engineers over the years. For example, Johannes Haarhoff's guidelines for dissolved air flotation.

What could the WRC have done to deliver more value?

- The workshop and conference presentation worked very well for knowledge exchange. Researchers are however limited by the number of workshops they can hold (budget constraints).
- The WRC should consider:
    - making more, or a separate, budget available for interactive workshops to assist knowledge exchange, and
    - tailoring workshops to target different groups. Follow different approaches for different target markets. Municipal manager vs Engineer. Overview vs technical.
- General recommendations for better uptake:
    - A mechanism to inform stakeholders of what is coming out by when, and to highlight past projects
    - Short video clips and discussions on specific projects (can be played at conferences)
    - Gaming theory: link knowledge exchange to a prize or competition.

Did the project deliver value to municipalities?

- Uptake in municipalities is often disappointing. Municipalities are inundated with documents and policies. So much is being thrown at them.
- Also, they do not have the right people, or enough people, to receive and use the information. Metros and bigger water boards have many engineers. But smaller municipalities and water boards rely heavily on consultants. Consultants must therefore be trained and well informed, otherwise the information will not get to the end-user. CESA workshops can be used as a conduit to transfer knowledge to engineers.

Relationship between WRC and Umgeni Water: What would you say delivers the most value to Umgeni Water? What can be improved?

- Most value: Opportunity for Water Boards to add more value to the objectives of the WRC through formal agreements like MoUs.
- Important to have regular opportunities for research partners to voice their research needs. Some institutions might be hesitant to share research needs on a public platform. Do not want others to see their weaknesses.
- Biggest challenge: The legislative environment restricts the contracting process. The PFMA[23] process of tendering is fair but is quite restricting and blocks the bulk of innovation in this country.

Do you as a Reference Group member try to facilitate uptake of the knowledge or is that not part of your role?

- Yes, make suggestions on who to target, give contacts, especially to academics who do not have relationships with partners.
- Umgeni Water has strong training and mentorship programmes. He always tries to include additional people in the Reference Group so that they can observe and learn. This is very important for continuity.

[23] Public Finance Management Act

The perspective of a beneficiary (end-user)

Overberg LM and a Belgian water services company used the model as well as Umgeni Water.

Project 2: Small-scale hydropower plants

Overview

The first WRC research project on hydropower was a scoping study conducted by Prof Fanie van Vuuren of the University of Pretoria's Department of Civil Engineering (Van Vuuren, 2010). The study found that the inlets of storage reservoirs have considerable potential for the generation of power. Municipalities, water supply utilities and mines who own and operate gravity water supply distribution systems could therefore be considered for small-scale hydropower installations[24].

After the scoping study, the WRC commissioned the University of Pretoria to test the feasibility of this principle with pilot projects (Van Vuuren et al., 2014). Three pilot plants were constructed at Pierre van Ryneveld reservoir (City of Tshwane Metro), Brandkop reservoir (Bloemwater) and Newlands 2 reservoir (eThekwini Metro). The City of Tshwane, Bloemwater and eThekwini were all collaborating organisations and supplied expertise and funding.

After the pilot project, the City of Tshwane appointed the University of Pretoria to investigate development possibilities at different sites in Pretoria (Loots et al., 2014). A 50 kW hydropower plant was installed at the Annlin reservoir; a 8 kW porotype was installed in Doringkloof. In 2017, the Metro signed a MoU with the City of Aarhus in Denmark. One of the planned projects is to install of a conduit hydropower[25] plant at the Salvokop Reservoir. The funder of the project is the Danish Ministry of Foreign Affairs.

eThekwini Metro also followed up on its project, and several other organisations are conducting studies. Rand Water for example is busy with a project that could potentially generate 15 MW of hydropower electricity. In Groblershoop, the generation of hydropower from a canal system was investigated (This study was funded by DSI).

In addition, the WRC and DSI appointed the University of Pretoria to identify potential sites and test their feasibility for small-scale hydropower development for rural electrification[26] (Bonthuys et al., 2016). As part of the project, the Kwa Madiba small scale hydropower plant was designed and installed on the Thina River within the Mhlontlo Local Municipality (OR Tambo District Municipality, Eastern Cape). The aim of the plant was to supply a community consisting of 55 households with electricity from hydropower.

[24] Small-scale hydropower refers to any hydropower plant smaller than 10 MW.

[25] Generation of electricity by placing a turbine within a man-made conduit, such as water pipes or canals.

[26] Bonthuys (2016:82) defines rural electrification as: "the provision of long term, reliable and satisfactory electricity service to households in remote, rural communities via grid or decentralized/centralized, renewable/non-renewable energy resources supply".

The perspective of the Research Manager

Mr Jay Bhagwan was the Research Manager. See the Pour flush toilets case study for his perspective.

The perspective of the Project Leader

The Project Leader is an academic from the University of Pretoria.

In general, what is the value of WRC research?

- WRC research is interesting and challenging and provides excellent networking opportunities.
- The water sector is privileged to have an institution like the WRC that has a continuous revenue stream for research.
- Provides a small supplementary income.
- Publications follow from WRC projects, which in turn help an academic like himself to enhance their CVs and build their careers.
- Research gets incorporated in new university courses and course material. Stimulating interest in new fields and building student capacity.

What value did the hydropower projects have for the intended beneficiaries?

- Hydropower delivers value to the country as a source of renewable energy. It is a value that is added to water. Also, source of renewable energy for the mining industry and large water intensive industries like Coca Cola.
- Still relatively new in South Africa. The full value has not been realised yet.

What were the spinoffs of the project or the knock-on effect?

- Current WRC project: developing a hydropower atlas for South Africa.

Did the projects build any capacity?

- Yes, several undergraduate and post graduate students were involved in the projects.

What was the value for you personally and for your institution?

- Broaden his knowledge and advance his career:
    - Opportunities to present at conferences over the past 10 years
    - Put him in contact with funding partners (MyLab in Switzerland, South Hampton University, the Danish government, University of Denmark)
    - Network opportunities with international experts in the field
    - Exchange students
    - International teaching opportunities
    - Opportunity to bring international experts on board as co-authors
    - Broaden networks through knowledge exchange workshops.
- For the University of Pretoria:
    - A number of students, workshops, local and international conferences and publications (He did not have the exact numbers, but it's all in his CV).
    - The WRC makes money available to the University to buy equipment, for example a flowmeter and logger, which can then be used in practical work and students' research.

- WRC funding empowers the University to offer students a bursaries. Offers valuable experience to undergraduate and postgraduate students working on the projects. Provides topics for fourth year engineering students' projects.

What is holding uptake back?

- Eskom and the regulatory environment held uptake back. For this reason, the Project Team tried to focus on areas where the beneficiary could directly use the generated power, for example in Bloemwater, the energy generated from the reservoir is used to power the offices at Brandkop. NERSA supported the pilot study.
- Bringing DWS on board was also a slow process. For example, the project at Groblershoop on the canal system of Boegoebergdam required permission from DWS. It took a long time, and the Project Team was sent from pillar to post.
- Several factors slowed down the KwaMadiba project:
  - Municipal approval was necessary, which was further slowed by the high turnover of municipal officials
  - Convincing the community that it is not "second grade electricity"
  - A flood, vandalism and a bankrupt contractor
  - Just before the launch date, Eskom installed and supplied electricity to the community.
- Smaller municipalities do not take ownership for maintenance.
- Funding of spin-off or follow-up projects.

What could the WRC have done to improve value for you and your institution?

- He does not think the WRC could have done more. Some circumstances are beyond their control.
- He believes there is room for a mechanism to make it easier for municipalities to get financing for projects. He has spoken to DBSA about it.

What could the Project Team have done to facilitate better uptake and impact?

- Could probably have asked the WRC for more help. Does not really involve the WRC in discussions and negotiations.

The perspective of a Reference Group member

The Reference Group member is an international expert in the fields of renewable energy, rural energy and energy efficiency.

In general, what value does the Reference Group contribute to a project?

- Gives the Project Team the opportunity to tap into the knowledge and expertise of experts from different fields.
- The Reference Group might know about similar research already available and can therefore also check the relevance of the intended research.

What was your contribution?

- Shared existing information that the Project Team could take into consideration.
- Gave advice on how to approach the project and what the priority areas should be.

What was the value for you personally and your company?

- Opportunity to keep abreast of what is happening in the sector and to identify possible collaboration opportunities. He did some work with a civil engineer that he met through the first project's Reference Group.
- He posted news about the projects on his company's website.

What could the WRC have done to deliver more value?

- In terms of the Reference Group structure, the WRC is doing a great job. He always gets the project information and documents early, which gives him enough time to prepare for the meetings.
- Virtual Reference Group meetings have pros and cons:
    - Pros: Able to include people from other provinces and countries.
    - Cons:
        - Not everyone is comfortable with using technology. In a recent Reference group, he realised that a very knowledgeable gentleman did not participate. He wondered if the person might not be comfortable with technology.
        - It is difficult to chat informally and network.

The perspective of beneficiaries: a student

What was your contribution?

- In his third year of undergraduate study, the student took part in some of the hydropower projects for the WRC. This sparked his interest in the topic.
- He was part of the Project Team of the study that investigated suitable sites for the development of small-scale hydropower plants for rural electrification. He did a full-time Masters study on the topic, which was funded by the WRC and DSI.

What publications or presentations followed from the research?

- Three international conferences:
    - International Conference on Energy Conservation and Hydropower in Seattle (2016) (won best paper award)
    - Hydro Africa in Marrakech (2017)
    - Hydro Vision in Denver (2017).
- Two peer-reviewed journal articles.
- Three popular articles in industry magazines.
- He tracks his citations using Research Gate and also has a Scopus account.

How did your career benefit from the project?

- Turning point in his career. The project helped him to select and solidify his specialist field as civil engineer.
- Catalyst for PhD, which he is currently busy with. For his PhD, he has already presented an international conference paper, and published three journal articles, a chapter in a book and two popular articles. "Without this project, this would never have happened".
- Networking opportunities, for example he met the hydropower specialist for Bloemwater (See 0).

What was the value for you personally?

- Personal satisfaction: The project aimed to contribute towards a social goal, to empower communities with rural electrification.

What value did this project have for the KwaMadiba community?

- Job creation and skills development: Used a PPP model to involve the community in the construction of the hydropower plant.
- Social empowerment: One of the community members, for example, learned to speak English while working on the installation.
- Sense of pride: The community is small, secluded and in remote part of the Eastern Cape. They felt very proud to be selected for the project. It gave them the feeling of: "We are not forgotten".

The perspective of beneficiaries: Bloemwater (end-user)

What did the project entail?

As part of the pilot project (Van Vuuren et al., 2014) the WRC and Bloemwater funded the design and installation of a 96 kW hydropower plant at the Brandkop reservoir. The plant was launched on 31 March 2015 by the then Minister of Water and Sanitation, Nomvula Mokonyane.

The interviewee was actively involved in the design and installation of the hydropower plant. He is also responsible for the day-to-day maintenance of the plant.

What value did the project deliver to Bloemwater?

- The hydropower plant supplies the Bloemwater head office building, which is located at Brandkop, with electricity.
- Publicity:
    - Project is the flagship pilot project for hydropower generation in South Africa.
    - Many schools, universities and water boards in South Africa and the rest of Africa have visited the plant.
    - Lots of media articles have been written.
- The technology requires minimal maintenance, and the expected lifespan of the technology is 40 years.
- The plant does not run all the time. It depends on the water levels of the reservoir. He therefore estimates that monetary savings is between R2,50 and R3,50 per kilowatt. And that Bloemwater's investment will be paid off in 14-20 years.

What was the value for you personally?

- Personal growth.
- Co-author of journal article.
- International visits:
    - Exchange visit to Malawi
    - Conferences in the United States and Australia
    - Training in Italy.
- Opportunities to act as consultant when he retires in two years' time.

Did you have personal contact with the WRC?

- Limited contact: met Mr Jay Bhagwan at a conference.

What were the spinoffs of the project or the knock-on effect?

- They did a feasibility study for a 400 kW hydropower plant between the Bloemfontein reservoir and Welbedacht dam. The results were very promising but due to cost containment, the project cannot be implemented at this time.

The perspective of beneficiaries: City of Tshwane (end-user)

The interviewee is the engineering consultant responsible for the Salvokop hydropower plant project, which is one of the planned projects under the MoU between the City of Tshwane and the City of Aarhus in Denmark. Even though this project is not funded by the Water Research Commission, it is an extension of the pilot project (Van Vuuren et al., 2014) and feasibility study (Loots et al., 2014). The interview shed an interesting light on the importance of sustainability and a conducive research environment.

How did the project come about and what will it entail?

The objective of the MoU is to build expertise and exchange information as well as to promote public participation among the following areas: city planning development, environmental sustainability, green building benchmarking and economic development and city growth.

Two projects were identified: to design and install a small-scale hydropower plant at Salvokop and to analyse water losses (non-revenue water) at the Pretoria West reticulation zone.

Salvokop was selected because it meets the criteria (listed in the first paragraph) and also provides an opportunity for a mixed-land use development, with offices, residential areas, possible retail outlets and restaurants, as well as heritage buildings like Freedom Park.

The University of Pretoria assisted the City of Tshwane with the feasibility assessment and design of a 152 kW conduit hydropower plant. This was funded by the Danish Ministry of Foreign Affairs.

The City of Tshwane must pay for the implementation of the plant, which includes purchasing the equipment and paying the contractor who will install the plant. They are busy with a tendering process to employ this contractor. The interviewee hopes that the tender will be finalised by the last quarter of this year (2021).

The City of Tshwane will also pay the University of Pretoria to supervise the installation of the plant.

The project also involves close collaboration with the Department of Public Works because they are the custodians of the land at Salvokop.

What will the benefits be for the City of Tshwane?

The interviewee mentioned that the hydropower plants that were installed as part of previous projects (including a WRC study) are not operational anymore due to vandalism. “They were vandalised before we could see what they were capable of and show the benefits”.

The Salvokop reservoir is in a reserved, guarded area with security 24/7. The City of Tshwane therefore plans to use the plant as a benchmark to showcase the benefits of hydropower using a proper report with statistics.

Have you had personal contact with the WRC?

He knows Mr Jay Bhagwan through the previous research that was done at the City of Tshwane. He attends WRC workshops and webinars from time to time.

Project 3: miniSASS

According to Graham and Taylor (2018), miniSASS is a low technology, scientifically reliable and inexpensive participatory tool which can be used by anyone to monitor the health of a river. The tool is a citizen science version of the South African Scoring System (SASS) method, which was developed by Mark Chutter in 1992.

SASS is used by trained practitioners to identify the health of water bodies based on the identification of up to 90 invertebrate families. miniSASS includes thirteen family groups of macroinvertebrates. The user collects a sample of macroinvertebrates from a range of habitats and flows within the river. The user can then use miniSASS to identify the groups. Each family group of macroinvertebrates is allocated a score based on for example the species' sensitivity and tolerance to pollution. A total score is calculated based on all the groups found. The score reflects the present ecological state of the river ranging from natural to very poor.

Six years after its original development, the miniSASS tool was further refined (version 2) based on an audit of users' needs, expectations and the perceived limitations of miniSASS (WRC Report KV 240, K8/733). This project identified the need for miniSASS generated results to be submitted to a central database where results could be gathered, checked, stored and shared by national and international communities, with the most viable option being an online map-based portal. The WRC funded the development of the online platform, www.minisass.org (Graham et al., 2015).

miniSASS does not lend itself to commercialisation, but rather to the promotion of citizen science in monitoring the health of rivers and streams and to contribute to environmental education across South Africa. A number of schools, universities, NGOs and companies use the miniSASS tool on a regular basis (Graham and Taylor, 2018).

The perspective of the Project Leader

The Project Leader owns an environmental consulting company, GroundTruth, who works closely with many NGOs.

In general, what is value of WRC research?

- Provides opportunity and resources (money) to engage with topics of particular interest, which in your normal job you do not have the resources to investigate.
- Not sure about future engagement and involvement with the WRC:
    - Success rate of submissions are dropping, which is disheartening.
    - Don't believe WRC's review processes are objective enough. Ecological topics have suffered in terms of funding. Focus is more on social topics now.
    - WRC's rates are ridiculous, which also makes it difficult to submit proposals.

What value did this project have for the intended beneficiaries?

- Used by schools, NGOs, the Palmiet River Watch, the Mzunduzi Environmental Trust (DUCT) and the Envirochamps.
- Give tools of science to people who work outside the structure of normal sciences. In Mpophomeni (near Howick), the tool empowered the community to gain agency and social

momentum. They were able to identify problems and engage with plumbers to deal with these problems.
- Working the Envirochamps (DUCT) was a big win. They were unemployed people that were trained and given a sense of pride and purpose to take science into their own hands.
- Impact was not formally recorded.

What were the spinoffs of the project or the knock-on effect?

- Job stimulus project: hosted students (school leavers) and took them through a training programme (train the trainer). Well received by the Presidency who want to extend the programme to 10 000 students.
- Many informal spinoffs.
- Other WRC projects.

What were the knowledge exchange activities?

- Used communities of practice to get people on board. Identified champions and people already involved in these types of initiatives. Use of tool grew organically.
- Long list of knowledge exchange workshops (Table 16 in Graham & Taylor (2018)).
- WRC promoted tool at national water days.
- The South African Environment Observation Network (SAEON) promoted the tool at schools and communities.

Did the project build any capacity?

- Many students have selected citizen science (reference to miniSASS) as topics for Masters and PhDs. See Table 18 in Graham and Taylor (2018:126-128).

What was the value for you personally and your company?

- Networking opportunities: met people working in other spaces.
- Differentiated GrouthTruth: helped team to think more broadly.
- Developed a space for citizen science and new project.

What could the WRC have done to improve value for you and your company?

- Missed out on opportunity to capitalise and profile it more strongly. Could support the website further.
- Uptake is an organic, long-term process, must nourish it to keep it going. Need a long-term ecosystem to keep projects going after funding has ended.

4.1.3.1 The perspective of a Reference Group member

The interviewee is currently working as a Research Manager for the WRC. The interview therefore followed a different structure.

From the WRC's perspective, when would you call a WRC research project a success?

- There are levels of success.
- From an auditor/performance agreement perspective it would be when all aims have been achieved and deliverables submitted to necessary standard (output focus).
- Success goes beyond that: impact of project. Has this project changed anything in the real world? Look at impact in social, environment terms.

From the perspective of the WRC, is ''value'' and ''uptake and impact'' the same thing?

- Uptake and impact are subsets of value.
- Fact that research has been done has value in itself. Contributes to science and allows other researchers to build on it. But it is only part of the story.
- Students trained or graduated contribute tremendously to building capacity, but don't see that as uptake.
- Have to ask: who benefits?

How can the WRC develop capacity to measure the water value and environmental value that its research contributes?

- Must acknowledge that there are multiple dimensions of value. Only some can be measured in monetary terms. Some must be measured qualitatively, in more descriptive terms.
- WET-EcoServices project: one can measure positive movement after intervention. Pre vs post rehab. Measure improvement of wetland service. Don't have to translate to monetary terms.
- Tell social impact stories. For example, how research was translated into policy. Benefits happen through change in policy. Policies are not an end in itself, but a means to improve people's lives.

What are the indicators that demonstrate that the WRC supports or facilitates uptake and impact of RDI projects?

a. In terms of the research environment?
   - Co-creation: Break down separation between research generators and intended users.
   - Embed research: put researchers where the problems are; users become part of the solution.

b. In terms of the proposal and reviewing process?
c. In terms of the project roll out
   - Mechanism to ensure outputs can be measured and researchers are held accountable for what they promised in the proposal. What products are you going to produce? Is it the right way to get to the audiences?

d. In terms of taking the knowledge into implementation beyond the project end date?
   - a, b and c create pipelines for implementation. Must think about and plan for implementation early on. Can't only think of end-user at end of project. Reference Group is therefore very important.

Any areas where you feel the WRC can do more, or do things differently?

- Take a wider view on value and impact. Look at it in all its dimensions. Ensure continuity between a, b, c, and d.
- Tell impact stories.

You've been a Reference Group member of several projects. What value did this role have for you?

- Incredible learning experience.
- Opportunity to contribute. Feel like skills can be deployed to add value to project.
- Make connections with people.

- Take knowledge back to sphere of work.

From a Research Manager and a Reference Group member perspective, what is the role of Reference Group members to facilitate uptake and impact?

- Bring potential users of knowledge into group. Not only about experts. The earlier they are involved the better.
- Composing a Reference Group is an art. Members must complement each other. Need 360-degree coverage. Can became "going through the motions".
- To improve uptake: People must know why they are part of the group. What is their role? Need constant focus, end point is beyond final report.
- Online Reference Groups have a far better attendance, and you can add people from all other the world. But you lose the informal interaction/networking. People can easily slip away: how present are you really in an online meeting? Chair's responsibility to make it an engaging meeting and create space for people to hold a discussion.

The perspective of beneficiaries: a student

The student works for the WRC.

What did your research entail?

The purpose of the study was to explore the perceptions and experiences of participants who have used miniSASS to monitor the river health in the uMngeni and Msunduzi catchments in KwaZulu-Natal.

How did your career benefit from the project?

- The WRC on an annual basis give their employees the opportunity to develop themselves through study grants. She opted for a course, a Masters study, to enhance her career.
- After the completing her Masters study, she got a promotion.
- She has completed a second Masters study (also focusing on monitoring and evaluation).

What publications or presentations followed from the research?

- She has been postponing writing an article on the topic. Plans to do it soon.

What was the value for you personally and for the WRC?

- Personally:
    - Interesting and challenging journey: reading and indulging with reports and other research.
    - Opened eyes to sector: better understand of 'who is who' in the sector.
- For WRC:
    - The WRC purchased the citizen science tools from GroundTruth in 2013. Since then, they have done many demonstrations and offered training. They promoted the tool at DWS's Youth summit. They took school children on field visits. It is a popular tool that can be used in different provinces.

What value did this project have for the intended beneficiaries?

- Valuable tool that changes the way people think about the environment. Also changes the way decisions are made with regards to managing catchments and rivers. Even DWS has incorporated the tool into some of their programmes.

- The Palmiet River Watch uses miniSASS as a community monitoring tool.
- The use of the tool by communities in the Msunduzi and uMngeni catchments has led to local government authorities responding faster to solving incidents of industrial pollution, addressing poorly maintained water infrastructure and fixing leaking sewers contaminating freshwater.
- The tool builds capacity in schools, especially in rural areas. Learners become passionate about improving the status of rivers.

The perspective of beneficiaries – Palmiet River Watch (end-user)

The Palmiet River catchment comprises some 25 km of stream length and includes residential, commercial, industrial, informal housing and natural areas (two nature reserves). The Palmiet empties into the uMngeni River estuary. Over the years, residents often complained of visual pollution, foul-smelling and dead crabs, fish and other animals, originating from sewage pollution, trade effluent pollution, and freshwater pipe-bursts, stormwater damage, dumping in streams and rivers, and defective septic tanks. (Cele, 2015).

The Palmiet River Watch was formed by one of the residents, who managed to recruit all the households along the banks of the Palmiet to take part in the monitoring of water quality (In 2015, the River Watch group comprised 250 active monitors/citizen scientists). The Forum operates through a WhatsApp group, on which members report incidents of pollutions. The coordinator then reports the incident to eThekwini Metro to take action.

Prior to the formation of the Palmiet River Watch… pollution events often went undetected, contaminating the river water continually; and complaints often went unresolved. River Watch reporting revealed that severe pollution events take place regularly, and continually destroy riverine habitats and annihilate the creatures that belong in the catchment (Cele [2015] reporting on an interview with the coordinator on 22 January 2015).

The actions of the Palmiet River Watch enabled the authorities to trace pollution to its source, identify polluters and take corrective action, often within a few hours. According to the interviewed coordinator, miniSASS has helped in tracing upstream conditions and adjacent land-use activities polluting the river (industrial, commercial, residential, open space, and informal housing) (Cele, 2015).

When the miniSASS assessment was undertaken in November 2013, the river looked and smelled terrible and was almost devoid of any form of life. Only one minuscule worm, a tiny crab and one snail was found. The most recent miniSASS assessment revealed that there is currently an abundance of insects and other organisms in the stream. It will take time for the chemical pollutants to leach out of the subterranean soils (Cele [2015] reporting on an interview with the coordinator, 22 January, 2015).

Project 4: Pour flush toilets

Overview

This project investigated the potential for modifying the pour flush design, which is widely used in Asia, to meet the needs of South Africans (Still & Louton, 2012). The Project Team measured the experience of South Africans with low flush systems in past and related technologies using three case studies. A prototype was developed and tested, and then piloted in 20 households in KwaZulu-Natal. The systems were monitored over the course of the project and performance and user experience were assessed at the end of the project.

The pilot project saw strong support from government institutions, municipalities and civil-society organisations. Environsan Sanitation Solutions provided expertise and support for upscaling the project in 2012 and have since commercialised the pour flush toilet.

Perspective of Research Manager

Mr Jay Bhagwan was the Research Manager of this project.

What is value?

- Success is measured by different criteria. To measure success, ask: Will the project have an impact? What will be the influence? Measure effect of research afterwards (uptake and implementation takes time).
- WRC did impact studies on different domains a few years ago. Realised it's hard to measure impact and direct/indirect influence. Impact does not look the same for each project, it is not set in stone. For some projects, it is possible to do a cost-benefit analysis.
- Various factors outside the WRC influence uptake and impact. It is not a system that the research institution controls.
- The research environment is not the same space as for example commercial product development. Its trajectory is different, the environment in which it plays out is different, hence indicators look different and more difficult to measure uptake and impact.
- WRC never played significantly on upper chain of innovation (industrialisation and commercialisation). Getting a lot more focus now. Innovation and Impact division is opening up pathways to modern platforms beyond research reports. To get the report repository moving, instruments are needed. Pipeline to get it moving. New instruments to drive uptake and impact.

Pour flush toilet project: Was the project a success from your perspective?

- Yes, it disrupted policy. Alternative solution to deal with the challenges of on-site sanitation.
- Product was commercialised. And spurred the development of alternative products. Becoming the alternative norm to on-site sanitation where water is limited.
- Intended for rural and informal settlements.
- Advantages:
    - Better, more stabilised sludge management.
    - Feeling of dignity: do not have to use a hole in the ground.
- Challenges:
    - Only sold by specific contractors. If product is marketed and endorsed by government, it can have greater reach in the commercial space like being sold by Builders.

    - WRC can't control the way beneficiaries take up the technology. In some areas, local plumbers jigged the toilet to make it a normal flush toilet. It did not work because toilet was not designed to have that function (does not have a cistern).
- Best way to measure impact: speak to users, tell their stories, do impact studies.

Social franchising project: Was the project a success from your perspective?

- Project started as a conceptual idea, a forecast. Operation and maintenance are low hanging fruit. Social franchising model was used to formalize the process. Targeted school sanitation for demo and full-scale implementation.
- Governance killed the project. There was not vested interest to take it forward.
- The WRC is just a catalyst in the chain. How do we make an impact as catalysts?
- Best way measure impact: in financial terms, telling users' story.

As a Research Manager, how do you ensure that the knowledge that your projects produce is taken up by the intended beneficiaries?

- There is no written formula. You need to have passion for innovative solutions. And a passion to drive the solution to its end point, uptake.
- Institutional vehicles like WADER and SASTEP help to get solutions to the marketplace.

How do demonstrate value to municipalities and DWS?

- Need more technical expertise in municipalities and DWS. They are consultant dependent.
- Important for organisations to see the relevance in RDI.
- Important to have formal partnerships between the WRC and the government and industry. Also, important to bring in beneficiaries in partnerships throughout the process.

Perspective of Project Leader

The Project Leader owns a consulting engineering company. They work mainly with developing communities.

In general, what is value of WRC research?

- Interesting, improves understanding. Answer questions with practical, applied research.
- Rate must make it worthwhile to put in a bid. WRC expects lower rates, big consultants can therefore not put in bids.
- Will continue to put in unsolicited proposals. Find them more useful than solicited proposals.
- Research Managers like Mr Jay Bhagwan likes new and interesting things (allows one to push the envelope) and is instrumental in getting money into the WRC through partnerships.

What value did this project have for the intended beneficiaries?

- For users:
    - Positive user experience: flush is political aspiration.
    - Maintenance: Low flush is easier to maintain and there are hardly any blockages.
    - Some perceive it as a second-class solution; want a cistern.
- Schools:
    - Maintenance is a challenge. Toilets at primary schools were better maintained than those at high schools.

- Slow uptake from government: it costs more, some engineers are conservative and there is a lack of awareness. Politics is always a factor.
- Project inspired Arumloo and Envirosan technologies.
- Percentage of toilets built in country is still small. 25 000 vs a few million Ventilated Improved Pits (VIPs). Recommendation is to gradually upgrade VIPs.
- Some DMs undertook their own projects. See 0.

What did the knowledge exchange activities entail?

- Presentation at WISA.
- Meetings with municipalities. Municipal officials are not good at reading reports. Difficult to get them to respond to surveys.

Did the project build any capacity?

- Yes, involve students from the University of KwaZulu-Natal in projects.
- Important that there is a clearly defined element for students.
- Acts as co-supervisor for students and is pretty hands-on throughout project.

What are the indicators of uptake and impact?

- Commercialised product
- Product enables users to move up on the sanitation services ladder.
- Conducive environment.

What could the WRC have done to improve value for you and your company?

- There's a vast amount of WRC information, people are not aware of. The new Knowledge Hub is difficult to work with. Can't find own reports.
- Some people in the sector don't even know the WRC exists.
- Provide a bonus or incentive system for uptake.

What could the Project Team have done to facilitate better uptake and impact?

- Not very good with publications (not an academic). Need to publish more in peer-reviewed journals like Water SA.

Project 5: Social franchising

Overview

In 2005, the WRC funded a scoping study to investigate the possibilities of the social franchising model being adapted for operation and maintenance of water and sanitation infrastructure in South Africa (Wall, 2005). The report highlighted the potential for social franchising to simultaneously deliver services and promote local economic development. Further studies explored how this concept would work, what resources were required, and the legal implications.

The studies led to an extensive pilot project that ran from 2009 to 2012 (led by Amanz' Abantu and funded by the WRC). A subsidiary of Amanz' Abantu called Impilo Yabantu (hygiene for the people) took on the role of franchisor to support local franchisee partners, which were mostly black middle-aged women. Under the Impilo Yabantu brand name, franchisees worked with municipalities in the Eastern Cape and the provincial Department of Education to tackle operational issues around sanitation and water infrastructure (Wall et al., 2019). The franchisees cleaned household and school toilets, removing the faecal sludge and disposing of it in a safe and environmentally friendly manner. At its peak, the programme services more than 1200 schools on a regular basis. Unfortunately, institutional and governance challenges at the Department of Education resulted in the contract not being extended beyond 2016.

The most recent extension to the programme was funded by the African Development Bank (AfDB), through its African Water Facility. The objective was to partner with the sanitation programme of the Department of Education and help enhance and scale up the programme to all schools (Wall et al., 2019).

Perspective of the Research Manager

Mr Jay Bhagwan was the Research Manager.

4.1.3.2 Perspective of the Project Leader

The Project Leader previously worked for the CSIR; he is now with the University of Pretoria.

In general, what is value of WRC research?

- Interesting topics which are of use to society.
- Contribute to social good: driven by value of water and sanitation.

What value did this project have for the intended beneficiaries?

- Created job and small businesses for the franchisees. If the project did not stop, the project had the potential to create 500 000 jobs.
- Clean and well-maintained toilets for the schools and households (until the funding ended).
- Was easy to get franchisees on board. Problem was finding clients that are willing to pay. Maintenance is never a high priority in terms of budget. Government do not use maintenance budgets.

What were the spinoffs of the project or the knock-on effect?

- Number of studies and projects followed the scoping study.
- Two WRC projects using the model is currently being led by other researchers.

Did the project build capacity?

- The franchisees were trained.
- Students were not a prerequisite in those days.

What was the value for you personally?

- Work satisfaction.
- Series of projects over 20 years.
- Publications and brownie points.
- Enabled the CSIR to get more funding.

What could the WRC have done to improve value for you and your company?

- If you want to entice people to become franchisees, a three-year project is not long enough. Income (making a profit) comes with time. A three-year contract is therefore not beneficial.
- Brilliant reports and projects (for example comic book for treatment works) that are not getting to the intended users.
- Workshops and webinars: always the same people attending.
- The school situation and how unions and the government work is not something the WRC can change.

What could the Project Team have done to facilitate better uptake and impact?

- Do not think they could do more. Project Leaders are burdened with their own problems: what energy do you have left to educate people?

Perspective of the research partner (franchisor)

In general, what is value of WRC research?

- Contribute to a solution: Interest in needs of people and practicalities and making water and sanitation work.
- Reputation and international recognition.
- Stimulate and drive innovation: funds available to try something different and new.
- Relationship with WRC developed over time. Met Mr Jay Bhagwan 25 years ago. He was a young activist at the time.

What value did this project have for the intended beneficiaries?

- Work and good income for franchisees and their employees. Some franchisees do continue to work but consultants get bigger cut of things.
- Upliftment of schools and households: better level of service; clean toilets.

What did the knowledge exchange entail?

- Requested by WRC to disseminate knowledge at workshops.
- Asked by African Water Facility to go to AMCOW meeting and bring franchisee along to address the meeting and tell them what she has been doing.
- Many publications and reports.

What was the value for you personally?

- See above.

Perspective of beneficiary: District Municipality (end-user)

The interviewee is an operations manager at Amathole DM.

What did the project entail?

- Amathole DM:
  - Six local municipalities fall under the DM.
  - Grant funded.
  - Water services authority responsible for provision of water and sanitation.
  - Most people they service are in rural areas and are indigent.
  - As part of their sanitation services, they provide pit latrines.
  - They have also piloted other technologies such as pour flush toilets. He mentioned that that pour flush is quite accepted even though people still prefer an easy flush toilet, which has a cistern. This echoes what the Research Manager and Project Leader of the pour flush toilet project experienced (See 0).
- They heard about the social franchising work done in the Butterworth district and expressed their interest in exploring how well the partnership model could work to empty household pit latrines.
- Partnered with Amanz' Abantu. Pilot project ran from 2006-2009.
- Franchisor was Impilo Yabantu and franchisees were a group local ladies. The franchisees established themselves. Franchisees were trained on health and hygiene and given suitable equipment (long spades, portable, sealed gallons, gloves, disinfectant, etc.).
- Villages were identified and the franchisees started to clean, maintain and rehabilitate VIPs that were starting to fill up. A pit takes about 5 years to become full.
- A second project ran from 2013-2016.
- Projects stopped when the budget ran out. They tried to craft a policy to be adopted by Council. Not implemented as yet.

Did you have personal contact with the WRC?

- First contact with the WRC was at a conference in Durban (no year given).
- He mentioned that his boss, Stephen Nash, has better contact with the WRC.

What value did the project deliver to Amathole DM?

- Franchisees: opportunity to work and earn an income.
- Impact on environment:
  - not all the VIPs were lined
  - full pits pose health risk to community.
- Villages: clean, well-maintained pit latrines. Household can use units again.
- Municipality: reduces backlog. Cost to install new VIP is between R12 000 and R15 000 while cost to empty is R2 500.

How could the project have created more value for Amathole DM or the franchisees?

- He feels sanitation, especially rural sanitation, often sits at the bottom of the priority list. This affected the sustainability of the franchisees.
- Literature and research on sanitation is also "a bit quiet". We need to make a noise about sanitation. Recommends the WRC talks to district municipalities about their needs.
- DWS is reviving the Blue and Green Drop and they are talking about No Drop, but where is sanitation? We need to influence the decisions of DWS. They need to take concrete

decisions, for example what do we do with dry sanitation? If the WRC can influence decisions in those high-level meetings, it would cascade down to the district authorities and be very beneficial for the sector.

4.1.3.3 Perspective of a beneficiary: franchisee

How did you become a franchisee?

- Went for an interview at the Amanz' Abantu offices. There was also a lady and gentleman from the WRC (can't remember their names).
- She was trained after being selected as franchisee.

Tell me about the work that you did? How many schools/households did you service? In which area(s)? Was it a good income?

- First project was in 2013. She was servicing 30 schools in Butterworth school district. Servicing included emptying pit toilets using a pump or a long spade if the sludge was dry. They were three franchisees in this area.
- After this project, she worked in King Williams Town.
- Just before COVID-19, she worked in Zwelitsha serving households (100 toilets in total).
- Income was good. She bought an eight-ton truck.

How many people worked for you?

- 10 people.

Are you still working as a franchisee for Impilo Yabantu?

- At the moment, she has no work. Her truck and pump are just standing.
- She is tendering for jobs, but jobs are scarce. There are many full toilets, but the municipality can't fund it. Also: "People will rather give the job to a friend".
- Impilo Yabuntu will contact her if there are jobs available.

How does it make you feel to be a franchisee?

- Very happy.
- She is training her two children to take over from her. Her son went with the franchisor to a presentation in Johannesburg (not sure what it was about).
- Many journalists spoke to her.

Was there anything about this franchisee project that disappointed you?

- Department of Education disappointed her.
- It was a big job that they lost because there was no money left.

Have you ever heard of the Water Research Commission?

- Yes, they fund(ed) the projects.

Project 6: A device to measure water use indirectly (ElectroFlo)

Overview

The National Water Act 36 of 1998, states in section 26 (b) that the Minister may make regulations requiring that the use of water from a water resource be monitored, measured and recorded. Regulations to this effect and applying to water users for irrigation purposes were published in 2017, 2018 and 2020.

Initial implementation of water measuring in irrigation schemes was limited due to various factors, including the alleged unreliability of the available meters at the time and management issues. To support water use efficiency in irrigation, the WRC initiated a series of projects to provide the needed research-based knowledge. The projects comprised:

1) Appropriate technology to measure irrigation water accurately: the device had to be accurate, tamperproof, easy to install and cost-effective (Du Plessis, 2004)
2) Guidelines for selecting, installing and maintaining meters (Van der Stoep et al.,2005)
3) A knowledge exchange project to bring the available knowledge for on-farm and on-scheme water measurement to farmers, managers of irrigation schemes, manufacturers of metering equipment and government officials (Benade et al., 2010)
4) Guidelines for implementation, and even more importantly, guidelines for managing the installation and maintenance of water meters (Van der Stoep et al., 2012), and
5) A communication strategy to facilitate uptake by commercial irrigation farmers (Slabbert et al., 2019).

The ElectroFlo project by Du Plessis (2004) addressed the need of appropriate technology. Flow meter accuracy was a primary concern for irrigators because they would be billed on the meter readings. The ElectroFlo project researched the indirect measurement of water with an electrically driven pump. An energy meter device was developed that converts the electric power that the pump uses into a flow rate. It also records the accumulative water quantity.

A prototype was developed and tested at the then Cape Technikon and subsequently tested at five sites on commercial farms, in conjunction with the Project Team who worked on the implementation and management project. The ElectroFlo meters were successfully commercialised and today they are widely used on specific schemes and on farms in the Western Cape.

The perspective of the Research Manager

The Research Managers of the ElectroFlo meter project were Mr Van der Merwe and Dr Mkhize (Mr Van der Merwe retired). Dr Gerhard Backeberg (also retired) managed the projects that addressed 2) to 5) above. Below is his perspective.

What is value?

In an article published in 2014 it is noted that ''for the purpose of agricultural water management, in particular irrigation water use, the knowledge generated through research has to meet the criterion of being useful for decisions and actions in practice. Research projects must therefore be purposefully directed and managed by following the innovation cycle or process. To achieve success, innovation must be pursued relentlessly" (Backeberg, 2014). He quotes Hamel (2012): ''innovation is the only sustainable strategy for creating long-term value''.

Did the ElectroFlo project create value?

The ElectroFlo meters were successfully commercialised and today they are widely used on schemes and on farms.

The trigger to start with metering/measuring of irrigation water was the cost of water supply and the need to more accurately know the volume of water used for better irrigation water management. This includes better irrigation scheduling and reducing the electricity costs of pumping water.

The time span from research to implementation is affected by the socio-political and regulatory context. Regulations like the ones mentioned in the first paragraph and their enforcement in practice can amplify the trigger (the need to meter), and thus accelerate an innovation's implementation. These regulations certainly fast tracked the implementation of the ElectroFlo meter.

What can the WRC do to deliver more value (improve uptake and impact)?

Backeberg (2014) refers to Drucker (1985) who said that research or knowledge-based innovation has the longest lead time of all innovations, and the highest risk. Experience also shows that it takes at least two to three consecutive research projects of high quality over 10-12 years before knowledge is created that is practically useful for decision-making and action. This is independently confirmed by Steiger (2013) and Holterman (2014).

For a successful innovation, the technology research has to be followed up with several high-quality research and development projects for technology exchange (Backeberg, 2014). Knowledge dissemination to the end-users does not guarantee uptake and implementation. It requires a multichannel approach that includes training, publishing popular articles, distributing audio-visual material, organising information sessions and practical demonstrations to the end users. Even more important is the intermediary network whose advice the end-users trust and follow.

As Slabbert et al. (2019) pointed out it is also critical that all aspects of the innovation, i.e. the technology and the guidelines for the management of use and maintenance, be regularly updated to ensure that they remain relevant.

From the perspective of the Project Leader

In general, what is value of WRC research?

- The WRC offered the opportunity and the funding to do an in-depth investigation and develop an idea into a device, which could be piloted, tested and eventually commercialized. It requires an interest in research and someone who is open to innovation.

What value did this project have for the intended beneficiaries?

- This project has beneficiaries at three levels: DWS as custodian of water and water use in South Africa, the management of WUAs (and irrigation boards) and irrigation farmers.
- After the device was built and tested at Cape Technicon, it was decided to pilot the device along the Orange river and in the Western Cape. Contact with farmers was made through the WUAs.
- The enthusiasm of Mr Hanke du Toit in all three beneficiary roles was instrumental in the uptake of the device (former DWS official, CEO of Oranje Riet and irrigation farmer).

- Initially farmers did not see the value, but they began to understand the value as the device was implemented by WUAs.
- The device delivered the most value to the regulatory function of DWS and water management at scheme level. The value that water measuring has for greater on-farm water use efficiency is a much slower process. The Project Leader is currently in discussion with agricultural consultants like GWK on how the ElectroFlo meter can be better applied to this end.
- Many irrigators still regard water measuring as a policing system, but they acknowledge that rivers and schemes cannot be managed without water measuring.

What were the spinoffs of the project or the knock-on effect?

- WUAs became the main users of the device. The WUAs know exactly what they want and has to do in terms of water measuring. For example, in one instance a WUA asked the Project Leader to write specifications for water measuring for its members. The specifications were channelled through DWS, but they are in essence a service for WUAs.
- The Project Leader currently has very little contact with DWS.

Did the knowledge exchange activities add value?

- Knowledge of the device spread by word of mouth and through personal networks.
- The Project Leader did very little active marketing. He was still employed at the time and didn't want to take the financial risk.
- The first large scale installation happened at the Breede River WUA. The CEO took the initiative.
- As a result of water measuring regulations, the WUAs were looking for a cost-effective solution. They found the ElectroFlo solution through their networks.
- The WRC also spread the word through their networks and through seminars. The WRC helped the Project Leader to build networks.
- The Project Leader had a working relationship with people in the Western Cape Department of Agriculture. They were very interested in the ElectroFlo meter and spread the word to irrigation farmers in their area.

Did the project build any capacity?

- The WRC insisted that the project involve a tertiary institution. Two undergraduate students and a lecturer from the Cape Technicon were involved in the development and testing of the device.
- Piloting at test sites also built the capacity of WUAs and the farmers who were involved.

What are the indicators of uptake and impact?

- Number of WUAs who have installed water meters
- Number of water meters installed
- Direct abstractions from river: Reconciliation of licenced water use and actual water use
- Reduction in water unaccounted for
- Greater water use efficiency in agricultural sector

Were there any value adds?

- The meter shows the user electricity use in real time. Assists with electricity management.
- Communication system, modem, and App.

- Measures pressure and water quality. Many farmers apply fertilizer through an irrigation system. The meter shows an accurate reading of how much fertilizer has been applied.

What was the value for you personally?

- Project leader established his own company.
- Increased his knowledge and insights into different aspect of water measuring. He brings this in-depth knowledge to the table when dealing with clients.
- Broadened his networks through the project, not only of potential clients but also of knowledgeable people.

What could the WRC have done to improve value for you and your company?

- The WRC was a wonderful partner. They encourage WUAs to use the product and the product was included, together with other water meters, at different forums (for example at training sessions for DWS officials).
- The project ended with a report in the virtual library. It would have been good if the WRC had some kind of mechanism to establish and measure what became of project X.
- A community of practice of researchers whose products has been taken to the market would also be a useful opportunity to learn from others. It would also be a learning opportunity for the WRC. However, the Project Leader realizes that the WRC has limited human resources.

What could the Project Team have done to facilitate better uptake and impact?

- The research and pilot accomplished what they set out to do.
- The commercialization could have been faster, but it was a risk for the Project Leader and there were teething problems with the American company that supplied some of the components.

From the perspective of a Reference Group member

In general, what value does the Reference Group contribute to a project?

- Not role of Reference Group to be the messenger, it is role of the Reference Group to contribute to the knowledge that is being produced.
- Technology transfer projects followed the completion of the project.

What was your contribution?

- She was also the Project Leader of a parallel project.
- As a result, the project in which the technology was developed and piloted and the project that developed guidelines for implementation and management collaborated closely.
- The Research Manager(s) had the insight that irrigated agriculture needs not only technology, but also guidelines on implementation and management.

What was the value for you personally?

- She came from academic background, the Reference Group exposed her to the challenges of implementation and commercialization. It was an eye opener to see how much effort is needed to achieve research uptake and behavioural change.
- Networking: meeting knowledgeable people you would not have otherwise met.

- Access to new knowledge. Opportunity to see new methodologies and results. Karen Germain's project made a significant contribution to knowledge on water use and irrigation in South Africa.
- Used knowledge as lecturer at the University of Pretoria. Also used knowledge as consultant in agricultural sector and also for course material.
- When she was a lecturer at the University of Pretoria, research was part of her KPIs. Her involvement with the WRC became less when she became a consultant. WRC funding is ideal for academics, because it is supplementary to an income. The funding is inadequate for a consultant without a basic salary.
- She learned that the buck stops with the Project Leader. It requires a lot of commitment and hard work from the Project Leader, because nobody on the Project Team works fulltime for the WRC.

What value did the project have for your organization?

- Involvement in Reference Groups sparks topics for final year engineering students' research projects.
- New knowledge can be built into university courses.

What could the WRC have done to deliver more value?

- Not an easy task to select the right Reference Group. Reference group members need to understand that they can't steer the project away from the contract that has been signed. She recommends that that the Reference Group include people that were involved in the reviewing process. This would allow Reference Group members to give input before the final contact has been signed.
- In her experience, it was often a scramble to get Reference Group members. Some people see the task as a liability. Some people who were proposed never came to meeting. When a project goes sticky, Reference Group members tend to disappear. It is likely that the online format will result in better sustainability of Reference Groups.
- She experienced the change from annual progress reports to deliverables. Deliverables became boxes to tick. As a researcher, she found it sometimes restrictive.
- It is very important to involve the industry that will eventually use the knowledge. Very difficult for a researcher to identify exactly what it is an end-user needs from a project. It was therefore very valuable for the Project Leader to test the technology on-site in two water use areas in real world circumstances.
- It is also important to involve people with commercial and marketing backgrounds in the Reference Groups of these type of projects. The Project Leaders of many WRC projects are scientists. They seldom have commercial or marketing experience. This would shorten the time to market.
- Although the project led eventually to commercialization, it took an enormous effort and probably personal money for the Project Leader to do this. The effort had to come from the Project Leader, there was little support from the WRC in this regard.

From the perspective of a beneficiary

The beneficiary is the CEO of a Water User Association.

What is value?

- For the WUA, it is important to have knowledge of successful practices. Where has what worked, and how well? They do not rely on marketing information or theoretical knowledge.
- The WRC is not a port of call when this type of knowledge is needed.

Did the project deliver value to you and the WUA?

- Yes, but indirectly. The Project Team tested the device on the CEO's farm, and that is where he first got to know about the ElectroFlo meters.
- Based on this experience, the WUA recommended the device to their members, and eventually became an agent for the ElectroFlo meters.
- The WUA extended the knowledge they gained with the pilots with knowledge of successful implementation with a learning journey to the Breede River WUA where they saw how the meters were used on-scheme.
- Real time information was a key benefit of the ElectroFlo meters, but the WUA needed the support of a service provider to achieve this. The result was a modem that sends the information directly via the internet to the WUA. None of the water users need to send in a meter reading.

Does the WUA or the CEO get value from the WRC?

- The CEO does not receive communication from the WRC. He does not know what the WRC is doing that could be useful for them.
- He has been on a Reference Group.

How can the WRC deliver more value to you?

- By assisting with the practical implementation of the ElectroFlo and other meters, for example a course in calibration.
- By researching Apps that provide technology in a hands-on, real-time format. ''Nowadays, farmers don't want to attend meetings to get information''.
- Areas where they need more research-based knowledge: The use of magnolite for water grasses and hydroelectricity on canals.