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„ВОДОСНАБДЯВАНЕ и КАНАЛИЗАЦИЯ" ООД ПЕРНИК

COLOPHON

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- Maastricht University Science, Technology and Society studies (MUSTS), Maastricht, The Netherlands (coordinator)
- Laboratory of Citizenship Sciences (LSC), Roma, Italia
- Water Engineering Development Centre (WEDC), University of Loughborough, Loughborough, UK
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This resource file provides background material that accompanies the publication:

> Wiebe E. Bijker, Giovanni Caiati and Luciano d'Andrea (eds.), *Knowledge Brokerage for Environmentally Sustainable Sanitation. Position Paper and Guidelines.* Maastricht, 2012

The publication can be ordered by sending an email to Prof. Wiebe E. Bijker (w.bijker@maastrichtuniversity.nl). The book's price is € 15. The book is also available as pdf file on the BESSE website.

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CONCEPTUAL STARTING POINT FOR BESSE

MUSTS: WP7 based on Project Formulation

By Wiebe Bijker

FOREWORD

We include this short text since it provides the original perspective adopted by BESSE, during the initial phase of the project, on what knowledge brokerage (KB) is. This should be useful when compared with the evolution of the concept of KB developed afterwards, with special reference to WP2 and the lessons learned through the pilots. It may be used for drafting the introductory part of the guidelines.

Knowledge Brokerage (KB) is the process by which knowledge and technology are transferred from one entity to another in order to assist and encourage improvement for both organisations and the individuals they employ.

Proposal Background

In the BESSE proposal we wrote:

- 'Knowledge brokerage methods (are meant) to overcome (…) hindering factors and to maximise the exploitation of knowledge relevant for Sustainable Development'.
- BESSE aims 'at starting up a learning process on knowledge brokerage in general, as a tool for the socialisation of Scientific and Technological Research (STR)'.
- Necessary for a development towards sustainable sanitation is the 'development of visions both of the problems to be tackled (problem-setting orientations) and of the solutions to be developed (problem-solving orientations) which could be shared by the multiple actors involved in sanitation, (such as researchers, public utilities, professionals, policy-makers, national and local administrations, utilities' workers and end users). Developing such visions necessarily implies effective forms of knowledge brokerage allowing a meaningful communication of scientific and technical contents between different 'epistemic communities', each of them bearing a different technical and social competence with respect to sanitation-related issues'.
- 'the lack of orientation towards an environmentally sustainable sanitation is not due so much to the inadequate production of a body of usable knowledge in this regard, but rather to an inadequate management of social dynamics (in the broadest sense, and namely economic, cultural, political, organisational, psychological, cognitive ones etc.) connected to the production, accumulation, dissemination, use and valorisation of this very body of knowledge'.

Key Words

Knowledge: includes at least scientific knowledge, users' knowledge, and (ideas for) technological innovation.

Brokerage: is the intermediary (or 'boundary') work between places (or individuals or organisations) with more knowledge and those with less knowledge.

II KNOWLEDGE BROKERAGE AND INNOVATION IN ENVIRONMENTAL SUSTAINABLE SANITATION

LSC: WP7 based on WP2

This text summarises the document delivered by LSC after the completion of WP2. It provides:

1. An overall analysis on the resistances to innovation ;
2. Overall facilitating factors for innovation ;
3. A model of a techno-scientific innovation cycle
4. A model on the role of KB in sanitation .

The document includes a list of obstacles and facilitating factors, as well as a list on KB practices in sanitation. Both lists are in the last section of this document (see below).

This text will detail the theoretical approach developed by BESSE and show that KB does not only address the transfer of knowledge from research centres to utilities, but it is also pivotal in:

1. Sustaining change tendencies among companies and utilities;
2. Acting as a catalyst and amplifier for social and environmental demands produced in society;
3. Playing a 'lobbying' role with political, economic and cultural institutions.

INTRODUCTION

As already mentioned, the BESSE project stems from the belief that, the availability of new knowledge notwithstanding, most sanitation approaches in Europe are still based on old technologies and obsolete management systems. These systems do not adequately approach or respond to today's sustainability needs - needs which in the last decades have become increasingly pressing, such as reducing energy costs and limiting environmental impact.

In order to achieve these goals, sanitation technologies, which are more compatible with environmental needs, have been developed in recent years. These technologies, increasingly grouped under the label of Environmentally Sustainable Sanitation (ESS), have mainly been designed for developing countries but trends are showing that the same technologies are now beginning to filter through to the more advanced ones.

Their spread in Europe, however, faces significant obstacles. Although there is widespread recognition on how unsustainable the traditional sanitation technologies are, the inclination to adopt solutions based on ESS technologies and approaches still appears to be quite weak among the European sanitation players. This lack of progression comes despite the strong EU commitment to promoting and disseminating alternative technologies.

Given this complex picture, BESSE has pursued two main objectives:

- Explaining the reasons of the gap between the knowledge produced in scientific research areas and the knowledge that is actually being employed;
- Understanding the role of knowledge brokerage in bridging this gap.

At the outset, the research focused on **communication and knowledge management**, on the grounds that the weakness of innovation in sanitation was chiefly ascribable to impediments in communicating the already existing knowledge and technologies to those in charge of applying them.

Through a trial-and-error process, by using different approaches and survey instruments (international literature review, online expert consultation, in-depth interviews, focus groups, case studies, etc.), the relevant dynamics of innovation pertaining to sanitation in Europe gradually emerged. This insight into the forces at work shed light on both the challenges as well as the

successes that the sector is facing.

Results showed the presence of a much broader range of obstacles than initially expected. Serious widespread hindrances were identified pertaining to many aspects of innovation, such as:

- The way in which sanitation-related research is funded, conceived and implemented;
- The actual attitude towards innovation on the part of technology suppliers and utilities;
- The sanitation policies and, in particular, those aimed at innovation;
- The presence, also outside the experts' circles, of strong cultural elements (stereotypes, collective representations, professional cultures, etc.) influencing technological renewal.

The wide range of obstacles identified showed how the problem to be addressed not only concerns the transfer of knowledge made available by scientific research to the players who have to develop and practically applied it (especially technology companies), but also concerns all di-mensions and phases of sanitation-related innovation processes. This affects the relationships between many actors, including utilities providing sanitation services, local governments (who, in many cases, have ownership of the sanitation infrastructure), national governments (who establish the regulations, fund and drive the research in sanitation), the supranational organisations establish-ing norms and standards, local agencies, civil society organisations or envi-ronmental protection agencies.

In this chapter the main obstacles to innovation, as well as the main facilitating factors of it will be analysed. Both obstacles and facilitating factors will then be framed within the larger dynamics of socio-technological innovation. Finally, an attempt will be made to better understand the potential role of knowledge brokerage in supporting the Environmentally Sustainable Sanitation.

Furthermore, what is reported in this chapter is the result of an analysis conducted by consulting different information sources, including :

- a literature review on technological change in sanitation and on ESS;
- an online consultation of 38 experts from 14 European countries and 8 non-European OECD countries;
- 40 in-depth interviews conducted in Italy, Bulgaria, the Netherlands and the United Kingdom with sanitation actors and in particular with representatives of utilities, local administrators and representatives of public and private research institutions in the sector.

RESISTANCES TO INNOVATION

During the research four main forms of resistance to innovation emerged:

1. Technological Inertia
2. Collective Disengagement
3. Immobility of the Institutional Actors
4. Research Weaknesses

Each of these forms of resistance has been documented through the identification of many obstacles, some of which are mentioned in the following text (they are marked with a code, for example: O37). The full list of obstacles encountered during the research and a short description of each of them are listed in the appendix.

A. Technological Inertia

The most serious obstacle to knowledge brokerage in sanitation is the **sector's tendency for technological inertia**. The level of this inertia exists in varying degrees in the different national contexts. Technological inertia appears to be a complex non-linear phenomenon. It is the product of a set of factors giving way to (often) recursive cause-effect dynamics, vicious circles and negative synergies, curbing the transformation process of new knowledge into technological innovation. These factors can be briefly described as follows:

- The starting point is that utilities have a **low propensity for innovation**, both because they deal with large-scale infrastructure (O01) and because they have adopted an intrinsic orientation to maintaining their own internal processes.

- This difficulty in modifying technological structures emerges and thrives in a **general conservative culture** which does not value new knowledge and tends to refuse the risks implied by innovation (O04), also providing an ideological base to a conservative attitude (O05).

- Their limited orientation towards technological change leads utilities to develop a **non-strategic approach to innovation**. This makes them underestimate the importance of the social dimension of sanitation, not recognise the social, organisational and economic impacts of technology transfer (O06) and give low priority, in terms of innovation, to operation and maintenance aspects (O07). That is why many utilities prefer to outsource innovation-related activities, considering them peripheral to their strategic goals.

- Because of these general attitudes, **utilities are not well equipped to manage innovation processes**. In general, they show a negative disposition towards revising their internal organisational processes (O09) and keep a top-down bureaucratic approach (O12), while operational units tend not to interact with one another (O011). This implies that, even if they were willing to innovate, they would encounter difficulties.

- Since they are not very innovation-oriented, utilities often also show **poor control over their own knowledge dynamics**. In general, they do not apply knowledge management tools (O13). This frequently means that managers are not aware of the knowledge already available within their organisations (O14).

- The many factors described above contribute to making utilities **unskilled in managing knowledge transfer**. New technology adaptation to local contexts is often inadequate (O15); technology suppliers are keen to sell utilities ready-made technological packages (O17); small utilities are often induced to overestimate their capacity to absorb new technology (O16).

- Knowledge transfer to utilities is made even more difficult by their **limited planning ability**. According to the results of the research, planning quality tends to be low (O18) and short-term (O19). This implies that even the more innovation-oriented utilities meet serious problems in the shift from the experimentation of a new technology to its actual implementation.

- In the absence of a strong drive of utilities towards innovation, the whole sanitation sector appears to be characterised by **low levels of communication**. The different actors, who do not feel the need to exchange information and knowledge, tend not to communicate or only do so occasionally (O20). This tendency has an important impact on the relationships between research institutions and utilities.

B. Collective Disengagement

The technological inertia characterising the sanitation sector is rooted in a more general context of **collective disengagement on sanitation issues**. The fact is that the future of sanitation does not matter to many: it does not involve citizens and families; it seldom brings about the start of civil society organisations, local associations or civic networks; it is rarely a topic of discussion among citizens and local governments; it is hardly visible in the media. Although the situation is not uniform among the various European countries, **strong social mobilisation on sanitation is nowhere to be found**. The main obstacles connected to the collective disengagement can be summarised as follows:

- The first problem encountered in this domain is that of the **repression of sanitation in public perception**. We can talk of 'repression ' since – in the first decades after World War II – sanitation issues were perceived by people and were the object of significant public efforts. Today, sanitation issues lie outside the public view (O23) and the transition to more advanced forms of sanitation, based on wastewater reuse, is approached with suspicion and distrust (O24).

- This repression is based on the idea that sanitation has nothing to do with health and the environment (O26) and, above all, on the widespread **belief that traditional sanitation systems have solved the problem** of liquid waste management once and for all, without damage or risk for people and the environment (O27). This is the reason why sanitation is not successful in arousing public interest or in triggering new social drives.

- Another factor sustaining the trend of scarce social mobilisation in the sanitation sector is that people generally have **limited 'technological responsibility'**: that is, they rarely recognise a 'good cause ' in scientific and technological development – one worth engaging in (it is perceived more as a danger or risk factor) (O28). This is obviously a general cross-cutting phenomenon that particularly affects the sanitation sector, which is already removed from public opinion.

- A further problem, for the already difficult situation of social mobilisation in the sanitation sector, is the **active and conscious opposition of some professional groups**, (such as health professionals (O30), farmers (O31) and hydraulic engineers (032)) to a number of essential requirements for sustainable sanitation (wastewater reuse; decentralisation of sanitation systems, etc.). Without public debate, this opposition easily manages to block any moves towards innovation.

- The development of a social agency for sanitation faces yet another obstacle in the **disharmonic relations among sanitation key players themselves**, affected by stereotypes and cultural bias (for instance, the role of private firms in the management of public goods (O33) or utilities' interest in scientific knowledge (O34)). In this way, even those willing to make the efforts towards change may well buckle under the pressure of the obstacles.

C. Immobility of Institutional Players

The poor social mobilisation in the sanitation sector is associated with a **substantial immobility of institutional, economic and cultural players** who come into the dynamics of the governance of innovation in the sanitation sector. In this third type of resistance, national differences seem to weigh more heavily than in the others. Sanitation policies are strongly influenced by national trends such as the priority attached by the government to science and innovation, the quality of public administration, the government's capacity to plan or the attention given to environmental protection and energy saving. Nevertheless, even in countries where the context is most favourable, sanitation problems – and especially the sustainable sanitation approach – **encounter many obstacles in getting onto**

the political agenda. The research identified various hindering factors which can slow down, if not impede, the development of tools, norms and policies in support of research and innovation in the direction of a more sustainable sanitation solution.

- The starting point is that sanitation, in general, and **research into sanitation**, in particular, **does not ensure political priority** – especially in certain countries. Political institutions and many other players seem to show little willingness to progress (O35). Therefore, policies specifically addressing research into sanitation, where they exist, are weak and subject to frequent modifications, revisions, interruptions and route changes (O36).

- This limited efficacy of, and continuity in, policy action supporting sanitation research is also due to the **limited capacity of many decision-makers** and utilities to grasp and **interpret the social, technological and environmental needs connected with sanitation** (O37). The poor awareness and lack of vision has two consequences: on the one hand, they prevent an understanding of what is at stake in the adoption of measures geared to environmentally sustainable sanitation; on the other, they reduce the possibility of recognising the potential and added value of scientific and technological research (for example, in terms of cost reduction or control over energy waste and pollutants).

- In addition to these low levels of awareness, it was often found that **decision-makers and their staff have poor technical and scientific skills** (O39), which, in some national contexts, seems to be particularly prevalent. This reduces the capacity of key governance players to understand the elements of complexity connected with sustainable sanitation, be they those related to environmental dynamics (water cycle, nitrogen cycle, etc.), technical questions or social and organisational aspects.

- The incapacity to interpret social and technological needs and the lack of adequate techno-scientific competence, combined together, have a negative impact on the quality of research policies on sanitation. When they are actually developed, they are often **inadequate or incomplete**. This impacts on the quality of the interventions actually carried out, which often appear to be inappropriate, non-systematic and discontinuous as regards technical contents, mobilised resources and objectives (O42).

- One of the obstacles viewed as particularly damaging is the fact that **normative frameworks** in some countries **are largely insufficient to sustain broad innovation processes**. Overall – with some meaningful exceptions – normative action seems to be characterised by instability (O44), slowness (O45) and lack of transparency (O46). This situation hampers scientific and technological research and leads to a sense of distrust in innovative solutions that discourages investors in sanitation technologies.

- The establishment of research policies in support of sustainable sanitation is further hindered by the **low level of competitiveness inherent in the sanitation sector**. In comparison with other sectors, where the development of new technologies is a key asset for being competitive, in the water and sanitation market, which follows the rules of a regulated market, research and innovation are not rewarded as they should be (O48).

D. Research Weaknesses

Another key issue that knowledge brokerage aims to deal with is the **weakness of techno-scientific research in the sanitation field**. There is the risk that techno-scientific research remains scarcely relevant to the problems to tackle, for various possible reasons: it may be too limited and underfunded, too academic, unable to involve the right sanitation players from the outset, or not interesting enough to establish strong links with the sanitation technology market. Signs of weakness in

techno-scientific research on sanitation can be found all along the steps of the 'ideal' path, going from the identification of new demands for knowledge up to the development of new solutions able to match them.

- As various experts and representatives of utilities pointed out, the first major limitation of sanitation research is its **scant orientation to practice**. Researchers tend to develop their research programmes on their own, without any real understanding of how appropriately their research meets end-users' needs (O49). That is why research programmes risk being out of context and often, even when they are problem-driven, risk reflecting the researcher's point of view more than the end-user's required outcome.

- Significant obstacles are also found in the following step, i.e. the production of new knowledge. Firstly, research in sanitation is necessarily multidisciplinary in nature but, for different reasons, the level of co-ordination among the various disciplinary approaches is particularly poor. Consequently, **research in this sector tends to be highly fragmented.** Moreover, an academic approach to sanitation research is still prevalent (even with respect to problem-oriented research) and **disciplinary barriers are still in place** (O51). All these lead to further institutional, communicational and even normative barriers.

- Research activity in the sanitation sector seems to be characterised by isolation. Many **difficulties still arise in connecting sanitation research with global trends in research** (O53). Therefore, research activity remains commonly hooked to national agendas. In this way, research institutions fail to perform a function that they do well in other fields, and namely to link global knowledge to local problems. This inadequate internationalisation of sanitation research contributes to making research activities poorly capable of targeting their action towards clear application outputs (O54).

- Another problem emerging from the consultation of the various sources is the tendency for research to be self-referencing. **Research outputs are rarely evaluated according to the criterion of their innovation potential** (O56), nor are they managed in a way that allows their possible application. On the contrary, research evaluation is usually carried out following standard criteria, focusing on scientific advancements, but much less on the practical solutions it can contribute to develop.

- As for the following step, such as the actual dissemination of new knowledge in view of its practical exploitation, problems tend to further multiply. Researchers show a **limited propensity to communicate with companies, utilities and stakeholders**. Moreover, professional networks – which, in principle, should be strongly interested in performing a mediation role between researchers and end-users – are prevalently self-referential (O57) and remain closed to other sanitation players (O58).

- Finally, **problems were also found with respect to the management of knowledge produced by research** that could potentially have been useful for boosting innovation processes. Sources of information about scientific knowledge available are scattered and unrelated to each other (O59); in research institutions, contact persons (offices, officials, etc.) that utilities, sanitation professionals and other stakeholders can refer to are usually hard to identify (O60); within utilities and local authorities, experts, able to evaluate the innovation potentials of available knowledge and to interact with research institutions, are lacking (O61).

FACTORS FACILITATING INNOVATION

In addition to the large number of obstacles, a set of factors facilitating the innovation process emerged in the major areas of environmental research and, to a lesser but growing extent, also in the sanitation sector.

The tendency towards **technological inertia** in the sanitation sector is contrasted by the attempts of numerous players who try new solutions. These attempts are based on trends which are stronger in other sectors but are being seized by innovation drive utilities, and by using knowledge management mechanisms and tools.

Within this general framework, a number of trends can be observed. A first trend is **acting on utilities' organisation and procedures**, by introducing quality management tools or modifying organisational arrangements. Another trend is **strengthening relational networks among the different players** involved in innovation processes, leading to the building of communities of practices, the establishment of innovation clusters and the development of widespread networking activities. **Greater attention to communication** is found in sanitation utilities, and, in general, in all enterprises providing public services, as a necessary tool for service production, interaction with users and coordination with local players.

Finally, a pivotal factor is the huge **increase in the amount of available information on innovation**, mainly due to the vast amounts of information available electronically and on the internet which is dramatically broadening the opportunities to access knowledge and exchange experiences.

Moreover, some trends should be helpful in countervailing the poor collective engagement with sanitation and bringing sanitation issues back to public attention by overcoming strong cultural barriers, the resistance to innovation of certain groups and the weak attitude towards cooperation of others.

A general trend which, in the middle- and long-run could boost the formation of a social agency in the sanitation sector is the **increased social pressure on environmental issues**. An important role is also played by the capacity of civil society bodies and ordinary people, to act on these issues, not by merely asking questions, but by addressing the most technical and scientific aspects, in order to influence the solutions to be adopted. Another general trend which, could help to counter the general orientation towards disengagement, is the increasingly widespread request of citizens **to have their voices heard** in the management of collective services and in the building of public infrastructure on their territories. This will improve the identification of transparency standards and new forms of communication with users. This trend, already well established in some domains (such as water, energy and health), could now be strengthened and extended to sectors which have as yet been less affected by it, as is the case with sanitation.

What has been said on the **immobility of the institutional actors** should not lead us to think that the situation is stagnant. Some factors and processes are nurturing conditions facilitating a higher engagement in sanitation research and the development of innovative practices.

Firstly, in the key domain of **research funding**, there is growing attention on the part of decision-makers towards sectors close to, or in continuity with, sustainable sanitation. This trend, which can be mainly observed in some countries, is also combined with a greater willingness to connect research and public policies. Even the ways in which funds are used is changing in many sectors.

In the last few years, especially in some national research systems, more attention has been paid to research technological outputs and the application of new knowledge to the solution of emerging problems of public interest. This inclination is expected to increase in the future along with a change in attitude to

research in sanitation.

The various critical points related to the **research weaknesses** detailed above should be tackled by leveraging the overall trends and disseminating good practices already tested in other European utilities and companies.

In this perspective, a first trend to grasp is the increasing development, in many national research systems, of **interdisciplinary research areas**, based on common research protocols. This usually results in the creation of journals, the formation of scientific networks and the development of university curricula no longer based on disciplines, but revolving around a consistent set of issues (i.e. a sector). This trend is already visible in the sanitation sector.

The road to post-academic science in the field of sanitation also passes through a **stronger social and economic contextualisation of the research activity**. This cannot be done in any other way than by putting in place tools and procedures aimed at grasping the demands for new knowledge expressed by sanitation actors and stakeholders, starting with utilities and companies. It is within this framework that some phenomena can be interpreted, such as: the diffusion of intermediate entities between science and industry, or the spread of research teams jointly promoted by research institutions and utilities. Another element which should enhance a post-academic approach in sanitation research is the **increasing capacity to communicate research results**. In various research domains, this attitude resulted in the development of new communication strategies which can be usefully applied in the sector.

Another result that emerged during the research is that the four types of resistance detected (technological inertia, collective disengagement, the immobility of the institutional actors and the research weaknesses) are not separated from each other but are closely interlinked. The lack of collective mobilisation in the sanitation sector promotes the immobility of the institutional actors which, in turn, leads to a lack of investment in the sector. This results in technological inertia that favours public disengagement on these issues. The limited collective mobilisation for sustainable sanitation in terms of environmental sustainability results in reduced pressure to modify the technology to determine the effect of low demand for new knowledge and the limited mobilisation of institutional actors in promoting it.

In order to map and clarify this set of relations in the framework of BESSE, a proposal for a model of a techno-scientific innovation cycle was devised, in order to properly 'place' each factor within a general picture. This model divides the innovation cycle into four processes:

1. The process of transformation of new knowledge into technological innovation;
2. The process of formation of social agency;
3. The process of institutional, economic and cultural involvement on innovation;
4. The process of activation, convergence and concretisation of scientific and technological research.

Each of these is a socio-technical process, such as a process in which not only technical and organisational aspects, but also social elements in a broader sense (communicational, economic, cultural, psychological, etc.) come into play.

Each process can also be understood as driving towards a specific social aim, be it that of turning new knowledge into technologies or that of activating public involvement and social mobilisation on specific public issues.

Each process partially involves different sets of actors, each bearing its own 'definition ' of the problems to cope with, and its interpretation regarding the possible technological solutions to be adopted.

Therefore, as a whole, these four processes define complex and nonlinear tracks through which scientific knowledge and technological innovation are socially shaped. They are one of the planes on which the co-

evolution of science and society develops. Obviously, the boundaries between the processes are variable and porous, with large areas of interaction and overlap.

A. Four Innovation Processes

Process 1. The transformation of new knowledge into technological innovation

This process is the segment of the innovation cycle in which **a set of knowledge produced by scientific research turns into new technologies** (and consequently new production processes, organisational practices, techniques, etc.). This is a structuration process, i.e. a process in which still socially 'fluid ' elements (ideas, new knowledge, etc.) tend to 'settle ' and solidify into new goods and services, in the form of specific products such as technologies, norms, technical standards, laws, manufactured products, plants or organisational forms. This is the segment where the final outputs of the innovation cycle are produced. However, to some extent, it is also the point from which the innovation cycle restarts, following an ascending spiral path. Through this process **research products spread into society** (in the form of new technologies, but also in terms of new potential, opportunities, social representations, etc.) activating a new chain of social changes (such as new lifestyles, personal and collective experiences, new identities, etc.).

Process 2. The formation of a social agency

In this segment of the innovation cycle, the social impacts of the spreading of goods and services based on new technologies **trigger new needs**, which progressively crystallise into **fresh demands for innovations** to meet these needs. This is prevalently an agential process in that it is characterised by forms of social mobilisation aimed at **introducing 'something new '** (for instance, new public issues, new points of view, new applications of existing technologies, new opinion movements, etc.). When these forms of social mobilisation reach a critical mass (for instance, by shifting from an individual to a collective dimension or by spreading in society), they tend to interact and produce social pressure to change.

Process 3. Institutional, economic and cultural involvement on innovation

Within this process, the social pressure for change starts having institutional, economic and/or cultural effects. The demand for innovation – which in the previous segment was still scarcely visible – now becomes evident, mainly when it involves important players such as governments, enterprises, political parties, the media, opinion leaders, professional associations and the like. This is clearly a structuration process through which **a demand for change,** that is still open and fluid, **enters the field of governance** and crystallises in the form of norms, laws, policies, action plans, investments, reference standards, shared values or behaviours.

Process 4. Activation, converging and implementation of scientific and technological research

In this last process of the innovation cycle, the involvement of institutional, economic and cultural actors drives the research players into action in order **to produce new knowledge**.

Consequently, new research programmes are launched, new research avenues are financed or new disciplinary or trans-disciplinary research areas are promoted.

This is by nature an agential process in that it is primarily sustained by the action of individuals and groups, with their own aims, passions, creativity, proactivity and skills, all channelled towards the discovery or the **invention of something new**.

Obviously, this process primarily involves researchers, research institutions and technology developers, how-

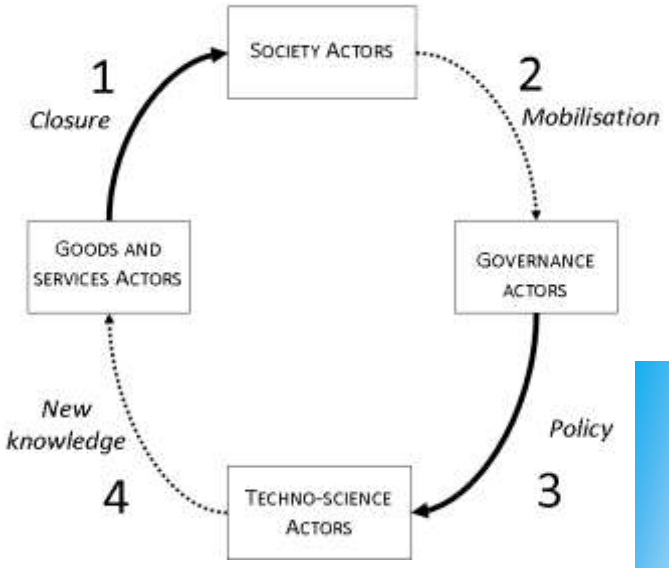
ever, a role is played also by other actors, such as research financing agencies, national and local administrations and, more broadly, all the players who, for different reasons and at different levels, come into the complex path of the production of new knowledge, ideas and technologies.

B. Dynamic Aspects of the Model

Some dynamic key features of the four processes deserve to be highlighted:

- The social aim of process 1 is that of turning new knowledge into technological innovation. It is here that research outputs come into the area of production of goods and services, through an action of 'technological closure', which involves various players (utilities, enterprises, research institutions, etc.). In its development, this process meets a set of specific obstacles that tend to slow down or even impede technological closure or hinder the spreading of goods and services in society: the so called '**technological inertia** '. The introduction of new technologies via goods and services has multiple impacts on society (in terms of new lifestyles, values, feelings, ideas, social relationships, etc.).
- This activates process 2, which is characterised by the formation, in society, of a social agency bearing new social, cultural and environmental demands connected to sustainable sanitation. In this case too, specific factors hinder the process, making social mobilisation on sanitation issues (albeit with significant national differences) generally weak; a situation which – even though to a varying extent in the different national contexts – can lead to forms of **collective disengagement**.
- Process 3 starts when these demands manage to create social pressure for change that is strong enough to progressively involve institutional, economic and cultural players. These actors give structure to the demands so that they can be put on the public agenda in the form of 'issues ' of public interest. In this way, specific governance mechanisms (norms, funds, policies, etc.) are set in motion. In this domain, the obstacles recorded refer to the '**immobility of institutional players** ', although they are coped with in very different ways and with varying degrees of success in the various national contexts.
- In process 4 (the activation, convergence and concretisation of techno-scientific research) the set of resources, policies and political plans developed in the previous segment favours or sustains mobilisation to generate new knowledge and to invent new technologies, which in turn activates a new process for the production of goods and services. Also with respect to this segment, a specific group of hindering factors (noted later in this document) was identified, related to the **research weaknesses.**
- The added value of the proposed model could be that of **giving dynamism** to the identified hindering factors, linking them to the key processes of the innovation cycle. In this way, each resistance can be 'placed' within the innovation track, albeit it according to prevalence criterion.
- The proposed model of the cycle of techno-scientific innovation is represented in Figure 1.

Figure 1 The Proposed Model of Techno-Scientific Innovation



THE ROLE OF KNOWLEDGE BROKERAGE

The analysis of resistances to innovation and their classification in a model of the socio-technical innovation cycle allows us to better understand the **weight of knowledge brokerage in Sustainable Environmental Sanitation**.

Three aspects need to be addressed:

- the operational concept of knowledge brokerage;
- the effectiveness of knowledge brokerage;
- the role of knowledge brokerage in sanitation

A. Operational Concept of Knowledge Brokerage

In the framework of WP2, an **operational concept of knowledge brokerage** was developed, based on the international literature. This operational concept defines knowledge brokerage as a **mediation process consisting of transferring knowledge between different** (social, professional, cultural, institutional, organisational, etc.) **contexts**. This process is performed both by specific professional figures in charge of carrying out activities explicitly connected with knowledge brokerage and by people playing other roles who, occasionally or marginally, implement brokerage-related activities.

According to this definition, knowledge brokerage is to be understood as a **widespread social phenomenon**. Knowledge transfer across different contexts is a process which continuously occurs in society. However, understood as an explicit and intentional activity requiring specific professional skills, knowledge brokerage is viewed as mainly aimed at activating links between players and networks of players who, in the absence of a specific mediation, 'naturally ' would not establish mutual connections.

Three action domains for knowledge brokerage were identified.

1. **Knowledge identification domain**. In this domain, knowledge brokerage is aimed at identifying (i.e. selecting and organising), among the available knowledge, those items potentially exploitable in terms of applications and technologies within a given sector (in this case, that of sanitation).
2. **Interaction domain**. In this domain, knowledge brokerage is aimed at creating a relatively stable, meaningful and effective interaction among actors who play or should play a role in exploiting new knowledge (scientific research, innovative companies, utilities, public administrations, etc.).
3. **Application domain**. In this domain, knowledge brokerage is strategically aimed at sustaining the transformation of new knowledge into innovation, which contributes to transforming it into concrete innovation of any nature (definition of new norms, activation of new research projects, application of new knowledge and technologies, etc.).

Needless to say, any single action of brokering may affect only one action domain or even only a single part of it. However, when viewed together, the three domains draw a framework which is complete in itself, including:

- The selection of useful knowledge (first domain);
- Its dissemination and elaboration through sharing (second domain);

- Its concrete application in technological terms or in other ways (third domain).

Finally, it is worth noting that knowledge which can undergo brokering can be of **any kind** (technical knowledge, social knowledge, normative and legal knowledge, etc.) and can be transferred in any form (orally or through written documents, images, etc.).

B. The Effectiveness of Knowledge Brokerage

Once the operational concept of knowledge brokerage was defined, the project attempted to deal with a **pivotal question**: to what extent can knowledge brokerage remove hindering factors and enhance innovation?

What has emerged from the BESSE project so far suggests that **knowledge brokering is a necessary but insufficient condition** for reversing the present trends in the sanitation sector.

It is not a sufficient condition insofar as it appears illusory and impracticable to cope with such widespread and deeply critical factors simply by resorting to brokering. By itself, knowledge brokerage can neither solve the problem of funding for sanitation research and modify the behaviour of actors who currently have no interest in innovation; nor can it bring about social mobilisation on sanitation-related issues if it does not already exist.

At the same time, **brokering is a necessary condition**. Promoting policies, actions or single initiatives aiming at even partially changing this state of things without knowledge brokering actions would be equally illusory and impractical. Knowledge brokerage seems to be indispensable to activate broader processes of change so as to produce a domino effect, thanks to its capacity to **recognise, amplify, transfer, connect and bring to a 'critical mass ' the existing forms of mobilisation**, be they individual or collective. This becomes an essential capacity when mobilisation is particularly weak and fragmented, as is the case with the sanitation sector.

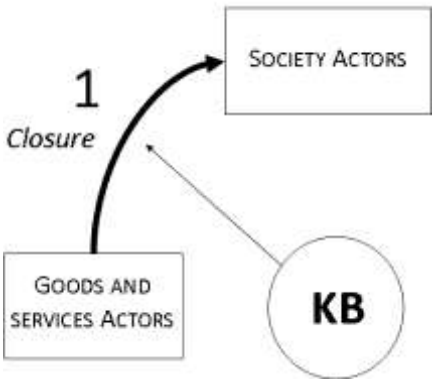
It is mainly this peculiar capacity to strengthen mobilisation which underpins the role of knowledge brokerage in the innovation processes in sanitation.

C. The Role of Knowledge Brokerage in Sanitation

The proposal of a model of a techno-scientific innovation cycle allows us to recognise the **specific strategic value to attach to knowledge brokerage in each of the process** included in the model**,** exercising a mediating action in different contexts and among different actors, and therefore performing a wide range of roles and functions.

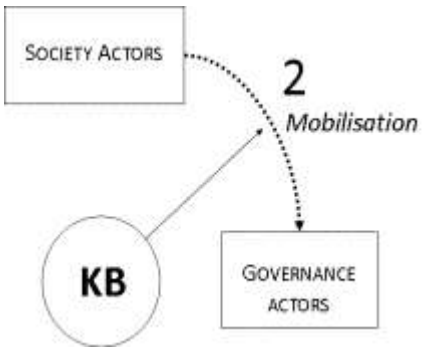
- Within process 1, the role of knowledge brokerage could be that of **sustaining change tendencies among companies and utilities** by increasing their awareness of the economic and environmental benefits derived from higher innovation rates in sanitation.

Figure 2 Knowledge Brokerage within Process 1



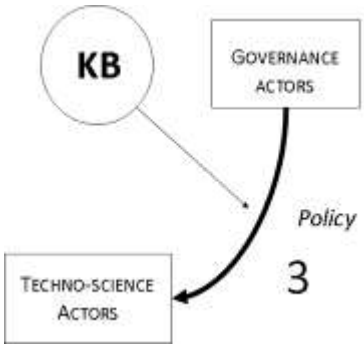
- Within process 2, knowledge brokerage could contribute to enhancing the strength of social agency by **acting as a catalyst and amplifier for social and environmental demands produced in society**.

Figure 3 Knowledge Brokerage within Process 2



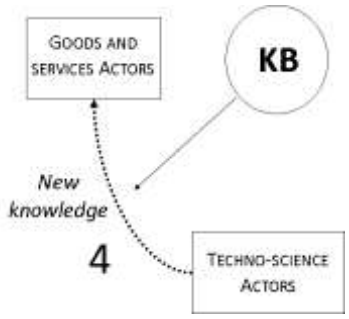
- Within process 3, brokering could play **a 'lobbying ' role with political, economic and cultural institutions** so that they might take charge of the tensions surrounding environmentally sustainable sanitation that are present in society, and support the research in this sector.

Figure 4 Knowledge Brokerage within Process 3



- Finally, within process 4, knowledge brokerage could **contribute to making research more relevant** in order to increase and accelerate its impact on innovation through dialogue, meetings and debates involving beneficiaries and institutions. This process would thereby support strong 'contextualisation' of research programmes in the domain.

Figure 5 Knowledge Brokerage within Process 4



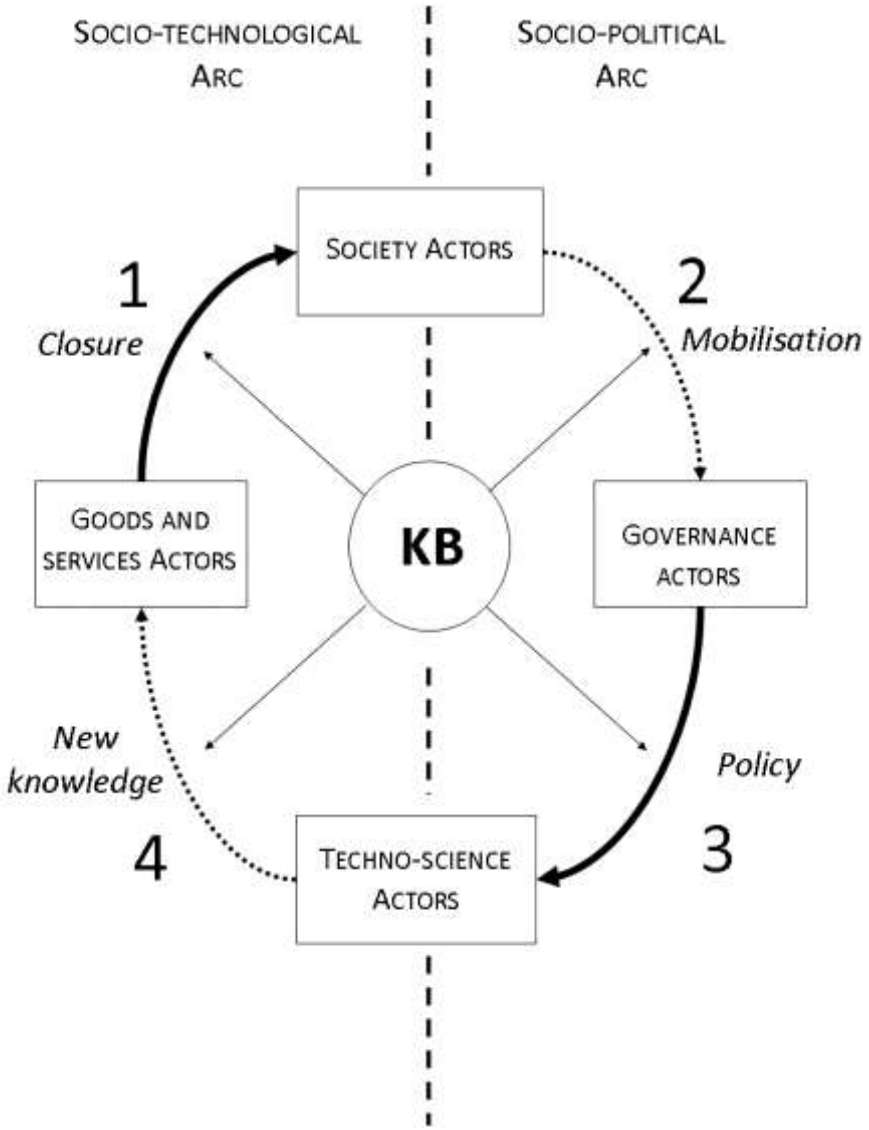
It is worth noting that, in the proposed model, **the scope of knowledge brokerage is broader than the one usually attached to it**. In the domain of innovation studies, knowledge brokerage is commonly recognised as a tool to speed up the transfer of existing knowledge from science to application.

This corresponds to processes 4 and 1 of the proposed model, which together form what may be called 'the **socio-technological arc** ' of the innovation cycle - that which proceeds from techno-science to society.

Following the model, it may be stressed that knowledge brokerage can play a significant role also along the arc proceeding from society to techno-science (processes 2 and 3), also known as the 'socio-**political arc**' of the innovation cycle, by sustaining social pressure for innovation so that they can reach a 'critical mass ', and contribute to turning them into a structured research demand. This interpretation is also compatible with the operational concept of knowledge brokerage premised in this report. This concept identifies three action domains of brokering – the knowledge identification domain, interaction domain and application domain – in which different types of knowledge can be managed: mainly technical and scientific knowledge, in the case of the socio-technological arc (processes 4 and 1); mainly social, environmental, political and legal knowledge, in the case of the socio-political arc (processes 2 and 3). As shown in the following picture, the proposed model assigns to

knowledge brokerage a key role in boosting the four processes of the techno-scientific innovation cycle, making it an equally important component of a general theory of innovation.

Figure 6 The Role of Knowledge Brokerage in the Proposed Model of Techno-Scientific Innovation Cycle



III

FINAL REPORT OF THE PILOT PROJECT IN BULGARIA

REGLO: WP4'

This text provides a full description of the pilot project in Bulgaria, including the main results.

Tables 1 to 4, showing the main problems to deal with and the possible use of KB (following the scheme provided in the previous text on WP2) may be particularly relevant for the guidelines.

The text is necessary for drafting the guidelines, to account for the activities carried out, and for drawing 'narratives ' or examples for inclusion(for instance in the form of boxes) of KB actions, mechanisms and outputs.

Based on this pilot project a description of 'evidences and outcomes' to support lessons learned is available but not included in this document.

Monitoring of the Quantities and Quality of Industrial Wastewater Discharged in Pernik Municipality Sewerage System

By Yantsislav Yanakiev

INTRODUCTION

The pilot project *'Monitoring of the Quantities and Quality of Industrial Wastewater Discharged in Pernik Municipality Sewerage System '* is part of the Brokering Environmentally Sustainable Sanitation for Europe (BESSE) project and is funded by the European Commission's Seventh Framework Programme 'Environment '.

This project has been implemented simultaneously with part of the basic local sanitation project in Pernik Municipality entitled *'Extension of Pernik Town Sewerage System '* which is funded by the European Union (EU) Cohesion Fund and the budget of the Republic of Bulgaria. The EU project is scheduled for the period between 2007 and 2013.

The Wastewater Treatment Plant (WWTP) 'Batanovtsi ', which collects industrial wastewater from Pernik municipality, applies traditional technology for *mechanical treatment on the first level and biological treatment on the second level.* The wastewater following these two steps of treatment is being discharged in Struma River immediately after the outlet from the WWTP. The maximum amount allowed, according to the existing regulations, is 13,560,000 m^3 per year.

The pilot project was implemented by the Research Centre Regional and Global Development (REGLO) in cooperation with Pernik Municipality and Water Supply and Sanitation (WSS) Company Ltd., Pernik from 1st December 2010 until 30th June 2011.

The main focus of the project is on increasing the rate of connection of small-scale industrial enterprises to the municipality sewerage system via introduction of knowledge brokerage (KB) mechanisms.

A. The Goals of the Pilot Project

Firstly, to identify specific knowledge brokerage mechanisms facilitating the connection of enterprises to the towns' sewerage system, and to improve the monitoring of the quality of the discharged wastewater.

Secondly, to improve inter-relations, information and knowledge exchange amongst various stakeholders in Pernik Municipality with respect to effective wastewater discharge in the sewerage system, and to stimulate effective law enforcement by making recommendations how to incorporate KB mechanisms in order to improve the efficiency of the process.

Thirdly, to stimulate and support the training of WSS company inspectors on the monitoring of the wastewater discharged by small-scale industrial enterprises into the sewerage system.

Fourthly, to increase the level of awareness of the local

population concerning the wastewater and sanitation issues, and the relevance of KB mechanisms for the effective handling of these issues.

The pilot project 'Monitoring of the Quantities and Quality of Industrial Wastewater Discharged in Pernik Municipality Sewerage System' was designed along the pattern of *action research.* The methodology includes *research as well as practical activities* aimed at increasing the capacity of the WSS company (through the training of inspectors) to monitor the quality of industrial wastewater before it is discharged into sewerage system.

In order to achieve the goals, several interrelated activities were planned and carried out in the course of the project implementation.

1. *A*nalysis of the current situation, or 'business-a-usual' (BAU), *identification and* assessment of needs of Pernik Municipality concerning wastewater treatment. This activity included the identification of knowledge needed for definition or re-definition of problems for introducing new technologies or improving the organisation of wastewater treatment processes. For this purpose, a precise mapping of environmental, financial, technological, legal, organisational, educational, political, value-normative, etc. handicaps in the way of the efficient treatment of wastewater was undertaken. Face-to-face interviews and focus group discussions with various actors were carried out in order to identify achievements, failures and prospects of KB involved or needed in the process of wastewater treatment.

2. *I*dentification of the main stakeholders involved in the handling of sanitation issues in Pernik Municipality. The divisions of the WSS company, the state institutions that are authorised to implement monitoring and control of water sanitation and small-size enterprises producing wastewater, were studied for possible conflicting interests among them. In particular, the municipality's documents were reviewed in order to identify the specifics of the relevant actors involved in the monitoring mechanisms envisaged by the project and the relationships between actors.

3. Mapping of resources available for connecting enterprises to the wastewater treatment system and for wastewater monitoring before discharging into the Pernik Municipality sewerage system. The implementation of this task constituted a substantial part of the project. In particular, the attention was focused on the identification of facilitating and hindering factors to both processes.

4. Identification of KB mechanisms that can be applied to improve the situation through consultation among the local actors. This was the core task of the project. The aim was to exchange technological knowledge, knowledge about sources of funding, about political support, pressures or other obstacles, about the involvement of the public in the decision-making process and in the control of the implementation of decisions, about options for upgrading the quality of organisational processes, the intensity and quality of the institutional information exchange, etc.

5. The collected information was used to *organise a workshop* (Appendix 1 Workshop Programme). The objective was to train the WSS company inspectors how to implement monitoring of wastewater discharged in the sewerage system and to implement effective control on this process. The workshop was designed as a *training-the-trainers activity*. The teaching methodology and the produced educational materials can be used as a model for further similar activities.

6. *The final step of the pilot project included a public presentation of the research findings and discussion on an* Action Plan for the implementation of the Programme for Monitoring of the Quantities and Quality of Industrial Wastewater Discharged in Pernik Municipality Sewerage System (*Appendix 2 Information brochure).* The aim is to initiate public discussions in order to raise the community aware-

ness regarding sanitation issues and to improve the mutual understanding among various stakeholders.

In addition to the above-mentioned activities, the Pernik Municipality provided extra funding and organised two expert studies: *(1) Design of methodology for mapping the sources/producers of industrial wastewater in Pernik municipality*; (2) *Design of alternative technologies for the utilisation of the sludge in the WWTP 'Batanovtsi '.*

A. Problem Situation

The process of connection of small-scale industrial enterprises in Pernik to the municipal sewerage system is not completed and the procedure is not clear. In the beginning of the pilot project there was no exact information available about the percentage of the small-scale industrial enterprises that produce and discharge wastewater in the town's sewerage system. In addition, the wastewater of the connected enterprises is not being monitored effectively, prior to its discharge into the towns' sewerage system, for dangerous components. This hinders the effective functioning of the wastewater treatment plant. In order to improve the situation, the WSS company has introduced a *Programme for Monitoring of the Quantities and Quality of the Industrial Wastewater Discharged in the Pernik Municipality Sewerage System*. The introduction of the system was an excellent opportunity to analyse and facilitate the KB mechanisms in order to change the existing unsatisfactory situation.

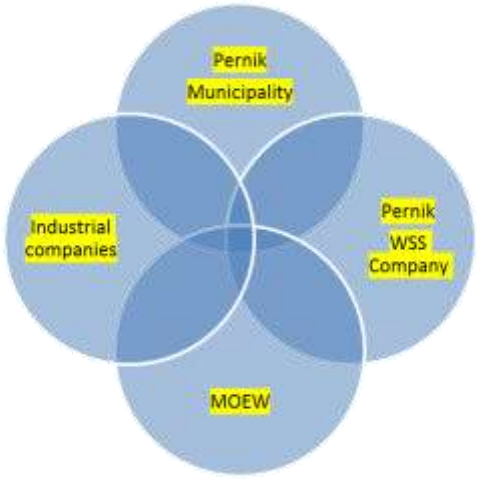
B. Identification of the Stakeholders Involved in the Sanitation Issues in Pernik Municipality

The main stakeholder issues regarding sanitation in Pernik Municipality are presented in Figure 7.

The *Water Supply and Sanitation Company Ltd*. is the main operator in the town of Pernik and the whole municipality. The ownership of the company is split between the state (51%) and the Pernik Municipality (49%).

Some of the primary activities of the company are: investigation, building, operation, maintenance and management of water supply and sewerage system as well as wastewater treatment in Pernik Municipality. The company serves more than 70,000 customers from the population of 138, 830.

Figure 7 Main Stakeholders with respect to sanitation Issues in Pernik



Being the owner of 49% of the company shares, the Pernik Municipality also has an important role to play in the sustainable sanitation sector. The municipality can be instrumental in providing data to monitor the emission norms of the dangerous and harmful emissions in the wastewater discharged into the sewerage system according to the existing regulations at national and local level. In addition, the municipality can provide control of these emissions at the exit of the WWTP, data processing and analysis with specialised software, etc.

Finally, the role of the municipality is also to exercise control on the procedures related to wastewater discharging in the town's sewerage system. The third major stakeholder in the effective industrial wastewater treatment process is *the Ministry of Environment and Water* (MOEW) which is authorised to implement mon-

itoring and control of water sanitation via its local offices (the Basin Directorate and the Regional inspectorate).

Last but not least, *important players regarding the sustainable water sanitation are the small-scale enterprises and the companies* producing industrial wastewater. According to the existing regulations, these actors are obliged to implement preliminary treatment to guarantee acceptable Individual Emission Limit Values of dangerous and harmful elements. At the same time, they are reluctant to do so because the technology is quite expensive and the small-scale enterprises are not motivated to implement it. The situation becomes even worse when one adds the *lack of effective control* on the side of the responsible state institutions. In fact, *the state institutions are not pro-active and do not implement their duties in the full spectrum, particularly regarding exercising control functions.*

Ideally, the state institutions, the municipality and the WSS company should be well interrelated and interested in supporting the innovation in the sanitation sector, including control on the quality of the wastewater discharged into the sewerage system. In practice the interrelations are rather weak.

To summarise, the key predicament is that the most important stakeholders in sustainable sanitation are not well networked and do not focus their efforts in joint activities to guarantee ecological and healthy environment in Pernik Municipality. The information exchange is a key setback. Therefore, in the pilot project, KB mechanisms were focused on *networking and active information exchange stimulation* as well as on *joint education* and exchange of experience.

Possible conflicting interests among the small-scale companies producing industrial wastewater and the rest of the stakeholders have been identified in the course of the research. The data from the focus group discussions and the expert interviews indicates expected *resistance on the part of some representatives of the local companies* to the implementation of the monitoring project based on financial reasons.

C. Identified Key Open Issues regarding Sustainable Sanitation in the Pernik Municipality and Possible Solutions via Inclusion of KB Mechanisms

The most *important open issues regarding sustainable sanitation* in the Pernik Municipality that have been identified in the course of pilot project implementation can be broken down into three groups.

First, effective law enforcement of existing normative basis for sustainable sanitation in the municipality.

- *The efficacy of the law enforcement has been one of the main problems when the present situation was analysed and assessed*. The control which is being implemented by the state institutions (Local Inspectorate and Basin Directorate of the Ministry of Environment and Water) on the quality and the quantity of the wastewater before discharging into Struma River is not fully adequate and timely;
- There are some normative obstacles hindering the implementation of the chemical treatment of wastewater in the WWTP.

Second, technological processes and organisation of wastewater treatment in Pernik Municipality should be improved:

- Some components of the *existing installations in the Wastewater Treatment Plant 'Batanovtsi'* do not function properly. This applies firstly to the primary sludge containers and on the second level, biological treatment does not function when the units are at full capacity;
- The *modernisation of the biological stage of the treatment of the sludge is a burning issue* with regard to the effectiveness of the WWTP. The treatment of the sludge and its utilisation is another

serious problem;

- *The management practices of the Water Supply and Sanitation Company in the previous years can be assessed as inadequate* as well as lacking in interest and professionalism, and hesitant to introduce innovations in the sanitation process. Examples are: perfunctory management of the sanitation process; some of the existing contracts between the WSS company and small-scale enterprises do not contain any specific requirements regarding the content of dangerous and harmful emissions in the wastewater according to the existing regulations;
- Next important problem is related to the *reconnection of small-scale industrial companies to Pernik Municipality sewerage system.* There are some enterprises and companies that are located in housing areas and discharge wastewater, which contains dangerous and harmful emissions, directly in the sewerage system without any initial treatment;
- The major problem is the *lack of effective monitoring and control on the wastewater content of dangerous and harmful elements* before discharging in the sewerage system;
- Last but not least, *the capacity of the organisation (WSS company) for introduction of innovations* and management of the sanitation processes, according to the existing normative basis, is still insufficient.

Third, better cooperation, information exchange and coordination between different stakeholders in exercising control functions and effective monitoring on the wastewater content before discharging into the municipality's sewerage system is needed:

- The cooperation and coordination between institutions which are responsible for the protection of the environment and for exercising control functions in the sanitation is insufficient;
- The local stakeholders dealing with sanitation issues are not well networked and are not efficient in resolving the task to guarantee the ecological and environment health within the Pernik Municipality*;*
- The information exchange between the state and the municipal institutions needs to be substantially improved;
- In addition to the regular control over the emissions in the wastewater of the new-build enterprises, the WSS company should review and revise the existing contracts where needed.

Tables 1 to 4 summarise *the main problems regarding sustainable sanitation in Pernik Municipality, possible solutions and perspectives, as well as the contribution of KB mechanisms* applied in the course of the pilot project implementation in order to change the existing situation.

Table 1 The Process of Transformation of new Knowledge into Technological Innovation

Problems	Solutions and perspectives	Contribution of KB
• *Lack of effective* monitoring *and control on wastewater content of dangerous and harmful elements* before discharging in the sewerage system; • Lack of *interest among local small-scale enterprises* producing wastewater to change the situation; • Conflicting interests with the rest of the local stake-holders; • Utilisation of sludge: primary *sludge containers* do not function properly; • The *modernisation of the biological stage of the treatment of the sludge* is a burning issue with regard to the effectiveness of the WWTP; • Normative obstacles hindering the implementation of *chemical treatment* of the wastewater in the WWTP.	• Spreading of quality monitoring and evaluation methods and procedures; • Increasing the involvement of different stakeholders in technical decisions; • Partnerships with non-competing companies in the city of Sofia and the town of Blagoevgrad.	• SMEs evaluation and recommendations on *alternative technologies for the utilisation of the sludge* in the WWTP 'Batanovtsi ' *(implemented by the municipality of Pernik);* • Design of *methodology for mapping the sources/producers of industrial wastewater* in Pernik *(implemented by the municipality of Pernik);* • *Improved cooperation* and information exchange with WWTP Sofia and Blagoevgrad; • Knowledge and information distribution on *legal issues of sustainable sanitation* in Pernik municipality.

Table 2 The Process of Formation of Social Agency

Problems	Solutions and perspectives	Contribution of KB
• The *information exchange* between the state and the municipal institutions is at very low level; • The *local public* is not well informed about the sanitation issues; • *The civil society structures* and *the citizens of Pernik* municipality have not been mobilised yet in the process of sustainable sanitation. •	• Environmental protection *public information activities* to change community perceptions and to help understanding the importance of the problem with wastewater treatment; • Stakeholders' tendency to have a *proactive role* in innovation; • Projects to *promote meetings among stakeholders*; • *Demonstration projects* addressing decision-makers.	• *Improved cooperation* among local stake-holders; • *Active involvement* of various local actors in BESSE project; • *The information campaign* initiated public discussions and raised the public awareness regarding sanitation issues; • Supported the new leadership of *WSS company pro-active role in monitoring programme* and helped to increase the capacity of the organisation.

Table 3 The Process of Institutional, Economic and Cultural Involvement on Innovation

Problems	Solutions and perspectives	Contribution of KB
• *Lack of effective law enforcement and control* which is being implemented by the state institutions on the quality and the quantity of the wastewater before discharging in Struma River; • *Low capacity of the WSS Company for introduction of innovations* in the management of the sanitation processes; • *Long-lasting wrong management practices of the WSS Company* in the previous years as well as lack of interest and professionalism; • The *cooperation and coordination between institutions* which are responsible for the protection of the environment and for exercising control functions in the sanitation is rather insufficient; • The *local stakeholders dealing with sanitation issues are not well interconnected* and are not efficient in resolving the task to guarantee ecological and healthy environment in Pernik municipality.	• Training projects on sustainable sanitation issues; • Increased *use of 'expert knowledge '* in decision making and public policy design.	• *The concluding workshop* contributed to training of the WSS Company instructors how to implement monitoring of wastewater discharged in the sewerage system and to execute effective control on this process; • Enhancing networking and *active information exchange among different stake-holders*, as well as joint education and exchange of experience; • *Stimulated small-scale enterprises* producing industrial wastewater to establish a contract with the WSS Company and to declare the individual emissions according to the type of the industry.

Table 4 The Process of Activation, Convergence and Concretisation of Scientific and Technological Research

Problems	Solutions and perspectives	Contribution of KB
• Problems identifying and attracting well qualified local experts on sustainable sanitation in Pernik municipality; • Lack of well-established cooperation between researchers and industry.	• Promotion of research teams involving both researchers and utilities • Conferences and events bringing together research and industry.	• Involvement of experts from *Sofia University and the University of Architecture, Geodesy and Construction* in the framework of BESSE pilot project.

D. Resources Available for Implementing Sustainable Sanitation systems in Pernik Municipality

The available financial, technological, material and human resources for resolving the identified key obstacles to sustainable sanitation in Pernik Municipality are extremely limited. Nevertheless, there are some possibilities for improving the process of wastewater treatment:

- The *available legislation* at national level and the existing regulations at municipality level could be better used for further sustainable sanitation development in Pernik Municipality;
- The *human resources of the WSS company* have relatively low capacities but they can be reorganised and motivated to participate in the implementation of a more efficient monitoring of main dangerous elements in the industrial wastewater discharged into the sewerage system;
- The *civil society structures* and the citizens of Pernik Municipality constitute potential factors that have not been mobilised yet;
- The *possibilities for information exchange in the framework of BESSE project* and on the basis of its outcomes could be used for this purpose;
- More *efficient cooperation and coordination could be achieved* between the municipality and the WSS company by using the permanent Inter-organisational expert council at the municipality level since it is responsible for issuing permits to the newly-built enterprises to discharge wastewater in the town's sewerage system.

Guaranteeing Sustainable Sanitation in Pernik Municipality via Knowledge and Information Brokerage

The assessment of needs in Pernik Municipality regarding sustainable sanitation reveals several domains or main spheres of knowledge and information that are summarised below:

First of all, the experts in sanitation in Pernik Municipality need knowledge of *state-of-the art technology to build a new WWTP*. They are convinced that partial renovation with limited financial resources is a temporary solution. The additional need for knowledge related to *introduction of chemical treatment of the wastewater* and the existing mechanical and biological treatment.

Moreover, they consider it important to obtain knowledge on treatment of the sludge by state-of-the art technology to produce biogas that can be utilised in the other industries. Furthermore, the WSS company needs *new knowledge management mechanisms* and *acquiring new knowledge about the procedures, for monitoring of main dangerous elements in the industrial wastewater* discharged in the sewerage system. Next, they need to acquire additional information and knowledge about the *normative basis and the existing procedures regarding wastewater discharge in the sewerage system monitoring*.

The WSS company needs precise and updated *information about the main dangerous and harmful elements contained in the industrial wastewater produced by the small-scale enterprises in the municipality*. They need knowledge regarding the exact types of dangerous elements that are being discharged into the sewerage system in order to exercise effective monitoring. Lastly, to implement adequate and effective monitoring, *specialised training of the inspectors of the WSS company* is needed.

The workshop that aimed to train the trainers was a first important step but the WSS company inspectors have to be trained about the technology of the corresponding industries, the mechanisms of the wastewater discharge, as well as their content (dangerous and harmful elements) according to Individual Emission Limit Values set in the existing regulations. Additional legal training is also needed.

Secondly, the local experts need more information and

knowledge on how to implement the project for wastewater treatment based on new technology, including mechanical and bio-chemical treatment. One of the main target groups that need additional knowledge is the group of people currently operating the WWTP technology with respect to how to monitor the process.

Thirdly, the research identified problems concerning the scientific support of sustainable sanitation in Pernik Municipality and difficulties in identifying and attracting well qualified local experts. Additional research is needed with respect to implementation of the Programme for Management of Industrial Wastewater Discharged in the Sewerage System of Pernik Municipality. *This project was actually linked with the improvement of the existing organisational practices, rather than introduction of new technology.* The main focus of this programme was on the initiative to *establish a system for monitoring of the wastewater before discharging in the towns'* sewerage system. It is high time to become aware of the problem that the content of the wastewater influences the effective functioning of the biological level of the wastewater treatment, quality of the sludge and the price of the treated water. Therefore, the introduction of a constant and regular monitoring of the content of the wastewater is critical. In this regard, the Action Plan for implementation of the Programme for Monitoring of the Quantities and Quality of Industrial Wastewater Discharged in Pernik Municipality Sewerage System should be further developed and put into practice.

The idea discussed in the framework of the pilot project was that the process would be implemented in three follow-up stages to improve the industrial wastewater management:

1. Each small-scale company or enterprise that produces industrial wastewater to establish a contract with the WSS Company and to declare the whole spectrum of industrial activities, related to wastewater production as well as the individual emissions according to the type of the industry;
2. To implement regular and constant monitoring of the quantities and quality of wastewater according to the declared individual emissions in the contracts;
3. The content of the discharged wastewater in the sewerage system of Pernik Municipality to correspond to the norms according to the existing regulations. The implementation of such a project is expected to have direct positive effects on the increasing re-connection of the small-scale industrial enterprises to the municipality sewerage system.

The next, particularly important, issue is related to environmental protection education and public information activities to change public perceptions and to help understanding the importance of the problem with wastewater treatment.

The experts participating in the interviews and focus group discussions were unanimous that the ecological consciousness of the local population in Pernik Municipality is not very well developed. On the one hand, the public is not well informed about the sanitation issues because they do not have a clear understanding of the ecological risk. On the other hand, there are more immediate issues that attract public attention such as unemployment, criminality, general poor economic situation, etc. Therefore, the experts consider it important to initiate public information activities to raise public awareness regarding sanitation issues. In addition, the experts think that civil society can implement control of the environmental pollution if they could see what the condition of the water in Struma River is. The people have to be informed of the ecological situation in the town, about their rights, etc. Furthermore, some of the experts mentioned that they can *work more effectively with the existing groups of interests* related to the protection of the environment in the high schools. There are some young people that demonstrate interest in the ecological issues and they would be happy to participate in workshops and training activities.

The media is very sensitive regarding ecological issues and can be included in a possible project to raise public awareness regarding sanitation issues. Finally, the experts again stressed that *the main problem is communication among the main institutions responsible for sanitation.* Therefore, they consider networking as a

very important element of the overall solution. Establishing these relationships can be achieved through the joint education and training of representatives of different institutions and their active participation in presenting their point of view and positions. It is important to stimulate dialogue, to take an active role in the discussion and to find a common position, not just to present different case studies or to deliver lectures. The training workshop and public information activities in the framework of the BESSE pilot project were a good starting point and created a model that can be further developed.

FINAL REPORT OF THE PILOT PROJECT IN ITALY

CNR: WP5

This text provides a full description of the pilot project in Italy.

The analysis of facilitating and hindering factors and the critical analysis are particularly relevant for the guidelines

The text is necessary for drafting the guidelines, to account for the activities carried out and as a source of examples.

Based on this pilot project a description of 'evidences and outcomes' to support lessons learned is available.

INTRODUCTION

In the context of the DG Research 7th Framework Programme, the European Union provided financial support to the 'Brokering Environmentally Sustainable Sanitation for Europe ' (BESSE) project, promoted and carried out by a consortium of nine research institutes and sanitation players. The project is aimed at supporting the EU Renewed Sustainable Development Strategy which is intended to increase the opportunities of interaction and cooperation between sanitation policies and research for the development of more sustainable sanitation in Europe.

The project has three main objectives:

1. To establish what obstacles are preventing the dissemination of scientific and technical sanitation information;
2. To identify knowledge brokering (communication) methods that will enable the sanitation sector to overcome these obstacles;
3. To start a learning process on knowledge brokerage in general, as a tool for the socialisation of Scientific and Technological Research (STR).

The main project output will be a set of policy guidelines on knowledge brokerage in support of environmentally sustainable sanitation.

The guidelines will be drafted on the basis of knowledge and information emerging throughout the research activity. The key steps of this research path are:

1. The research of the existing environmentally sustainable sanitation technologies (WP1) and the map of the obstacles and facilitating factors to knowledge brokerage in the sanitation sector in Europe (WP2);
2. The implementation of three experiments in Bulgaria, Italy and the Netherlands (WP 4, 5, 6).

The research activities were experimentally implemented in the pilot project of Castel Sant'Angelo di Rieti. The activities were carried out by the Water Research Institute of the Italian National Research Council (CNR – IRSA), the Municipality of Castel Sant'Angelo di Rieti (CSA) and by the Laboratorio di Science della Cittadinanza (LSC).

This document aims to describe the different phases of the experimentation and to discuss the results of the critical analysis of the whole process. The remaining part

of the report is articulated as follows:

1. Section 1 describes the process by which the final programme of the knowledge brokerage activities in the pilot projects was implemented.
2. Section 2 describes the actions undertaken, the problems encountered and the facilitating factors. To this aim, the results of the 'Map of hindering and facilitating factors ' have been taken into account.
3. Section 3 aims to analyse in a critical way the different phases of the process and to highlight the actual contribution of the knowledge brokerage.

PROGRAMME OF THE RESEARCH ACTIVITIES IN THE PILOT PROJECT

A. The Main Problem

Castel Sant'Angelo is a municipality in the Province of Rieti (in the Lazio Region– Central Italy) that has an extension of 31,321 km². An important groundwater source is located in the flat part of the territory, which results in several springs with significant water flows. Some of these springs are connected to the Peschiera aqueduct, which is one of the main water sources for the city of Rome.

The protection of the water quality in this aquifer is of outmost importance not only on a local scale, but also at national level. To this aim, a sustainable and effective management of the integrated water cycle is crucial for this area.

The current sanitation system is quite complex because it is composed of several sub-networks aiming to collect the wastewater in the small urban areas that compose the municipalities. A main conduit collects the water en route to the treatment plant. Most of the sewerage network was built during the 80's using concrete as building material. The reduced reliability of the network is due to morphology of the territory and the presence of a busy road (via Salaria). Several pipelines have been characterised by phenomena of flow, subsidence, or floating. The effects of these phenomena have been worsened due to incorrect choices in the design phase, for example, the main collector was built using 1-meter semi-oval concrete pipelines, which are particularly vulnerable to the above-mentioned phenomena. Most of the pipelines are characterised by low inclination and are immersed in the groundwater.

The connections between the different elements of the pipeline are becoming increasingly unstable and groundwater intrusion in the pipeline has been registered for several years. The wastewater is diluted and, consequently, the wastewater treatment plant did not function at its maximum capacity.

Several interventions have been implemented in the last years aiming to reduce the groundwater intrusion phenomenon. Particularly, a new collector was built using new materials to replace what was previous used. The infrastructure was built adopting new technologies and materials capable of preventing groundwater intrusion. This is expected to enhance the reliability of the wastewater treatment plant.

B. The Pilot Project

The main goal of BESSE in this pilot project was to activate awareness processes and to raise concern for the role of sewerage in the sustainable management of the integrated water cycle, and to enable the creation of a sense of ownership of the local community toward the new technology and, consequently, to accelerate the impacts of innovation in the society.

To this aim, BESSE facilitated the communication and knowledge exchange among the four most important actors involved in the sanitation management: the municipalities, the technicians, the scientists and the local

community. Several meetings were organised during the project implementation phase in order to elicit the information needs of the different actor. Specific topics raised included which kind of data should be provided to each actor, how to support the analysis of the data and how to facilitate the sharing of the data and information.

At the end of this phase, a programme for experimentation was developed and agreed upon with the local partners. The programme comprised three main activities:

1. *Integrated validation of the intervention:* the aim is to support the municipality in the evaluation of the effectiveness of the intervention. This activity starts at the end of the construction work for the main collector and aims to collect a significant set of data to verify whether the main goal - the reduction of groundwater intrusion in the pipelines – has been achieved or not. The following sub-activities were identified:

- *Programme of the validation activities:* a programme has been prepared by the scientists and discussed with local authorities.
- *Training of local technicians:* in order to facilitate the knowledge transfer from scientists to practitioners, a local technician was trained on the collection and analysis of data, in order to evaluate the reliability of the sanitation system and the effectiveness of the implemented project.
- *Implementation of the validation programme:* the implementation of the programme was supported by the BESSE staff.
- *Development of a website for data and information sharing:* the accessibility of information concerning the sanitation system is crucial to enhance the sense of ownership of the community toward the innovation.

2. *Programme of the long-term monitoring activities:* beside the evaluation of the intervention, there was a need for long term monitoring of the effectiveness of the innovation in terms of reduction of groundwater intrusion. Although it was not possible to implement the monitoring programme due to the limited duration of the trial phase, several activities have been carried out in order to provide the municipality with the needed knowledge:

- *Elicitation of the information needs of the main actors concerning the data to be collected to assess the reliability of the sanitation system:* interviews with municipalities and local technicians have been carried out to elicit which information is needed in order to evaluate the effectiveness of the intervention, how often the data should be collected, how to analyse data and to manage information. The results of this phase have been used as a basis for the development of the monitoring program.
- *Collection of the technical data concerning the network:* The design of the monitoring system required the collection of the technical data concerning the different parts of the network. To this aim, data, information and documents were collected from the different technicians that, over the years, worked on the whole sanitation system.
- *Development of a first draft of the monitoring programme:* using the data collected a draft monitoring programme was developed and discussed with local authorities and technicians.
- *Consensus achievement about the monitoring programme.*
- *Development of the final version of the monitoring programme.*

3. *Communication and information:* the final part of the BESSE experimentation in the CSA pilot project concerned the development of a communication and dissemination plan aiming to facilitate the creation of a sense of ownership of the community toward the technological innovation. To this aim, three main communication channels were enabled:

- *A website:* in order to facilitate the access to the

information concerning the reasons behind the development of the new infrastructure, to the data concerning the validation of the intervention and the long-term monitoring, a web site has been designed and implemented. Scientists, local authorities and technicians worked in close cooperation in order to provide the information and knowledge to be published on the web site.

- *A public conference*: a meeting was organised in order to inform the community with the information regarding the main challenges faced by the current sanitation system, the role of the system in the sustainable management of the water resources and the effectiveness of the technological innovation adopted to solve the main problems. Scientists, technicians and policy-makers collaborated to organise the conference.
- *Dissemination documents:* easily readable documents were written for distribution during the conference. The documents summarised the results of the project and the information contained on the website.

These three activities are described in the following sections.

1. Integrated Validation of the Intervention

A demonstration was planned in the municipality of Castel Sant'Angelo di Rieti (Italy), where there is an issue with groundwater intrusion into the sewer. This is due to a combination of an ageing sewer network and non-conducive local conditions (rising water table, geologic instabilities, etc.) that results in dilution of the wastewater collected and sent to the treatment plant, with consequent malfunctioning.

Another potential problem is possible leakages of wastewater from the sewer towards the water table - a precious resource because the area includes the main springs feeding the aqueduct for Roma. The municipality has tackled this problem by planning the replacement of the main sewer branches and utilising new materials for the limitation of losses/infiltrations to/from groundwater.

The aim of the demonstration was to assess the effectiveness of this action by monitoring the tracts of sewer already replaced in terms of quantity and quality of collected waste water.

Relative determinations between different points of the sewer will be performed by using specific instruments and measuring relevant parameters such as flow -rate, salinity, electrical conductivity, turbidity, pH, temperature, etc. The results will provide information on quantity and quality variability along the sewer, and allow for an evaluation of the effectiveness of the adopted strategy for limiting groundwater infiltrations in the sewer.

2. Programme of the Long-term Monitoring Activities

As a natural extension of the demonstration outlined above, a more comprehensive, complete, and effective monitoring plan including both the sewer network and the wastewater treatment plant, was proposed. It is expected that once the replacement of the existing sewer network with a leak-free collection system is completed, the average and peak wastewater flowrates reaching the treatment plant will decrease. At the same time, it is plausible to expect that the lack of 'dilution ' caused by the new system will lead to concentration increases of the main wastewater chemical/physical/biological characteristics. For these reasons, the wastewater quality and quantity will be subject to higher daily and seasonal variations (high tourist traffic in the area) than they currently are, requiring more careful operation of the treatment plant. In order to sustain the effective management of the whole wastewater collection and treatment system, the design and installation of a stable monitoring network will be proposed. This will include the installation of devices for measuring all the main parameters required for assessing the regularity of discharge from wastewater producers, also, providing a useful tool for detecting possible illegal dumping into the sewer. The

sewer monitoring system will have to be connected to a Supervisory Control and Data Acquisition (SCADA) system allowing for data elaboration and storage, and could be connected to another monitoring system specifically designed for supporting the wastewater treatment plant management and operation.

3. Communication and Dissemination

As stated previously, part of the activities carried out in the Italian pilot project concerned the dissemination of the information about the technological innovation adopted in the sanitation system. In order to enhance the accessibility of the information, three different kinds of communication devices were used.

A website was designed to publicise the main information concerning the role of sanitation system within the integrated water cycle, the main issues to be addressed in the case study and the actions implemented. The structure of the website is reported in the following scheme:

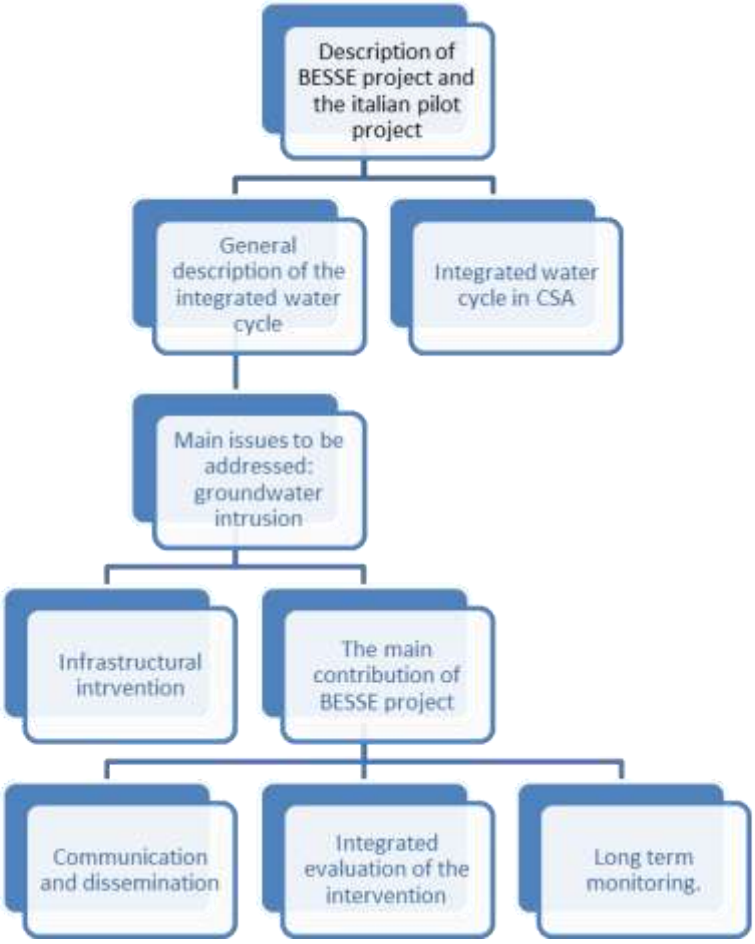
Figure 8 The Scheme of the Structure of the Website

The website is used to publicise the data collected during the integrated evaluation of the infrastructure, in order to make the evaluation process explicit and controllable by the public. Moreover, the data collected during the long-term monitoring phase will also be published.

Part of the documents available on the website will be summarised and distributed in brochure form. These brochures will be developed in order to enhance the comprehensibility of the information.

Table 5 summarises the activities and indicates the time of implementation.

Figure 8 The Scheme of the Structure of the Website



HINDERING AND FACILITATING FACTORS

This section aims to describe what happened during the pilot project with respect to the knowledge brokerage actions implemented, the obstacles encountered, the facilitating factors and the actors involved in the process.

Given the main goal and the activities described in the previous section, the actions undertaken in the pilot project aimed to collect the knowledge around the local sanitation system and to make it available to the different actors.

Firstly, the main actors concerned with the management and maintenance of the sanitation system - the local authorities, the technicians and the water management agencies – were involved in a communication exercise. In the early stages, the communication between the BESSE team and those actors faced certain challenges. Although the municipality of Castel Sant'Angelo is part of the BESSE consortium, the willingness of the local authority to take part in the discussion with BESSE experts was low. This was mainly due to the inherent difficulties to critically analyse their approach to sanitation system management. In the early stage of the project implementation, the local authority considered the planned, and partly implemented, intervention on the main collector of the sewage network to be extremely reliable, though willingness to discuss over it was low. This negative attitude drastically changed when direct contact was established between the local authority and the scientists interested in sewage network design and management. The debate amongst the scientists and the authority allowed them to ascertain that the monitoring of the network is the most urgent priority. The quality of communication with the authority continues to improve.

Table 5 Knowledge brokerage activities plan in the pilot project

Code	KB Action	Description	Times
A1	Integrated validation of the intervention	The aim is to support the municipality in the evaluation of the effectiveness of the intervention: • Programme of the validation activities; • Training activities involving local technicians; • Implementation of the validation program; • Development of a website for data and information sharing.	July 2011
A2	Long term monitoring of the intervention	The aim is to monitor in the long term the effectiveness of the innovation in terms of reduction of groundwater intrusion: • Elicitation of the main information needs of the main actors; • Collection of the technical data concerning the network; • Development of a first draft of the monitoring program; • Consensus achievement about the monitoring program; • Development of the final version of the monitoring programme.	End of the project
A3	Communication and dissemination	The aim is to facilitate the creation of a sense of ownership of the community toward the technological innovation: • A web site; • A public conference; • Dissemination documents.	July 2011

Another challenge was the communication with the technicians involved in the network management. In this instance, the main barrier was the lack of trust toward the scientific community. This barrier was overcome by supporting the dialogue between technicians and scientists, and making clear that the aim of the project was not to formulate a judgment on the different interventions carried out on the network, but rather to enhance the public awareness about the role of technical innovation in sanitation.

The last actor involved in this phase of the BESSE implementation was SOGEA, the water distribution management company.

The communication with this actor was hampered by the lack of trust toward the local authority. This is because SOGEA was not involved in the design and implementation of the intervention on the main stream of the network. Therefore, in the beginning of the process they were not as invested in knowledge brokerage. Their attitude changed when the idea of the monitoring system was proposed by the BESSE team. They agreed that the collected data could be really useful to support them in the management of the whole sanitation system.

Secondly, the technical documents concerning the sewage network were collected in order to develop the knowledge-base for the next phases of the BESSE implementation. This action was hampered by the lack of a central archive of the documents concerning the previous intervention on the network.

The lack of a systemic management and maintenance programme of the network resulted in a series of isolated interventions, decided on the basis of the available funds rather than according to structured planning and the local authority did not exert centralised control. This was because of the difficulties encountered by small municipalities to define long term economic and financial plans. This is a crucial issue which was not adequately addressed during the implementation of BESSE project.

The documents concerning the infrastructure were stored by the different technicians who worked on the infrastructure. This complicated the creation of the knowledge base for the BESSE project. Moreover, most of the information concerning the infrastructure is available only as tacit knowledge held by technicians. That is, the most experienced technicians have a qualitative knowledge of the actual position of the different parts of the network, whereas official documentation is missing. Time and manpower needed to be allocated for the collection and structuring of the dispersed knowledge and information. This work started during BESSE project because of the strong political will of the local authority, but more is still to be done.

CRITICAL ANALYSIS

This section describes the critical analysis of the role played by knowledge brokerage actions in supporting the technological innovation in the sanitation sector. As reported in the following table, the analysis was carried while taking the opinions of the involved actors into consideration. These focused on the problems en

countered during the knowledge brokerage exercise, the adopted solutions and future perspectives and, finally, the actual contribution of the knowledge brokerage process.

In order to identify the main processes, we referred to the knowledge brokerage cycle, as shown in Figure 1:

- Process 1: Transformation of New Knowledge into Technological Innovation. We referred to two different types of innovations: the innovations concerning the infrastructure and those related to the monitoring system.
- Problems:
  - The main problem concerning innovation in the sewage network was the difficulty to adapt the technology to the local context. During the debates with local technicians, researchers had the feeling that the technology adopted to reduce the groundwater intrusion had been borrowed from other similar projects, without deep analysis of the surrounding conditions. Moreover, we registered distrust toward the scientific knowledge in infrastructure development. Local technicians repeatedly expressed their

Table 6 Hindering and facilitating factors

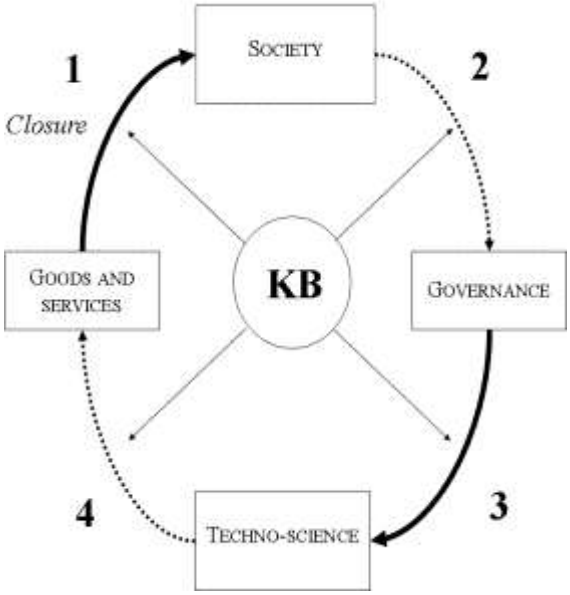
Code	Action	Obstacles	Facilitations	Actors
A1	Capacity building of the technicians	Due to the bureaucracy, it was difficult and time consuming to identify the technicians to be involved in the monitoring activities.	Remote training sessions.	Local technicians; local authorities; researchers.
A2	Enhancement of communication among the local actors	Local authority: low priority assigned to the sanitation; Technicians: lack of trust toward research projects. Water sanitation system management: weak involvement in the infrastructure design and development. All actors: lack of willingness to share information.	Collection and sharing of information. Establishment of a direct contact with all actors, and particularly with local technicians. More active involvement of local authority in BESSE activities.	Local authorities; technicians, water sanitation system management.
A3	Analysis of the infrastructure	High fragmentation of the maintenance interventions on the infrastructure.	Establishment of direct contacts with the different technicians.	Local technicians, local authority, researchers.
A4	Collection of technical documents	Lack of a centralised archive of the technical documentation. Dispersion of the technical knowledge. Prevailing of the tacit knowledge (experiences) over the coded knowledge. The technical documentation was not updated.	Political willingness to support the BESSE project	Local technicians, local authorities, researchers.

opinion that the available scientific research is not easily convertible into practical application.

- Problems have been encountered during the development of the monitoring system. Firstly, the implementation of the long term monitoring programme was not possible because of lack of funds in the municipality. This was mainly due to the difficulties experienced by small municipalities for the development of long term plans for infrastructures management. In this case, funds were collected for the intervention, but not for the monitoring or evaluation of its effectiveness.

- *Solutions:* in order to overcome the above mentioned problems, the BESSE team attempted to reduce the gap between the scientific and technical knowledge. To this aim, several meetings have been organised involving researchers and local technicians. The conceptual barriers were demolished when the BESSE team decided to shift the attention from the infrastructure development to the monitoring and evaluation. This change in approach and the subsequent improvement in communication and participation can be attributed to the fact that local technicians accepted that their knowledge and practices were not being challenged, but rather that a process of knowledge integration was ongoing.
- *Perspectives:* during the implementation of BESSE it became clear that a crucial element of the knowledge brokerage process is the financial and economic sanitation planning. Small municipalities claim that they know how to access different funding possibilities. Unfortunately BESSE was not able to support this learning process. It should be considered as a future priority.
- *Contribution to knowledge brokerage:* BESSE

Figure 9 Knowledge brokerage cycle



mainly contributed by reducing the distance between the scientific and technical communities in that several meetings involving scientists and practitioners were organised. During the debate, researchers became aware of the actual needs of local technicians and, consequently, research activities were discussed and reformulated to meet the technicians' needs.

- *Process 2: Formation of a Social Agency.* Most if the activities carried out in the pilot project aimed to facilitate the creation of a social agency through a process of awareness-raising.
  - *Problems:* at the early stages of the pilot project, there was a lack of awareness in the local community about the important role played by the sanitation system within the integrated water cycle. This resulted in a common disregard by the local community toward the technological innovations in the sanitation field.
  - *Solutions and perspectives:* to overcome the above mentioned problem, documents describing the local sanitation system within an integrated management of the water resources were distributed to the local community. In addition, a website was developed in order to facilitate the access to the documents and to publish the data collected by the monitoring system. This will allow the local community to take part in the evaluation of the implemented intervention. The data will be analysed and published in a format which will be easily understandable by non-expert people. The website will be periodically updated with the data collected by the monitoring system.
  - *Contribution of knowledge brokerage*: BESSE mainly contribute to the awareness of the local community and authorities of the importance of sanitation system to protect the groundwater aquifer.
- *Process 3: Institutional, Economic and Cultural Involvement on Innovation.* This analysis refers to the two main innovations in the pilot project: the construction of an innovative collector for the sewage, and the development of a monitoring system for the evaluation of the intervention.
  - *Problems:* As stated previously, the local technicians and authorities did not seem prone to critically re-think the interventions required for the infrastructure. Consequently, they were not positively predisposed to an ethos innovation. Moreover, due to undefined levels of decision making concerning sanitation, there are no clearly defined roles and responsibilities. This, in turn, results in weak willingness to investigate and adopt new technology.
  - *Solutions and perspectives:* BESSE activities encouraged the dialogue between technicians and researchers, and among the different decision makers. Nevertheless, this dialogue cannot be considered as an extemporaneous result. A protocol for frequent exchange of data and information should be defined through a more structured consensus achievement process.
  - *Contribution of knowledge brokerage:* the activities carried out in the pilot project ensured a decrease in the distance between technicians and researchers, and to make the scientific

knowledge easily implementable in practice.

- *Process 4: Activation, Convergence and Concretisation of Scientific and Technological Research.*
  - *Problems:* The main issue that has to be addressed in this process is the lack of synchronicity between policy-making and research. In the early stages of BESSE, the research was slower than the policy: while the BESSE team was still defining the plan for the activities aiming to support the local authorities in the implementation of the infrastructural project, the works were already finalised. This forced the BESSE team to adapt the plan. Later, during the BESSE implementation, the policy-makers were not able to provide timely responses to the researchers' request, for example, the identification of the technician for the fast evaluation of the infrastructure.
  - *Solutions and perspectives:* this issue has not been adequately addressed in BESSE. Nevertheless, we think that this is a crucial challenge for the knowledge brokerage research.
  - *Contribution of knowledge brokerage:* In order to address the issue of a-synchronism and to guarantee the success of the project, the BESSE team established continuous monitoring and evaluation of the activities. This allowed the team to adapt the plan of the activities according to the changing context.

CONCLUSIONS

The analysis of the experiences carried out in the CSA pilot project allowed us to draw some important conclusions concerning knowledge brokerage and how to support technical innovation in small municipalities:

1. Activities of knowledge sharing, which address the different sources of funding, are crucial- even more so than other activities. Due to the difficulties encountered by small municipalities to access to funds for infrastructures, the knowledge brokerage process should start before interventions are defined and should be of specific focus during the planning phase

Table 7 Critical Analysis

Process	Problems	Solutions and perspectives	Contribution of KB
The process of transformation of new knowledge into technological innovation	Lack of economic resources to be used for the infrastructure monitoring. Weak capability to adapt the innovation to the local context. Lack of trust toward research projects. The scientific knowledge is considered as not immediately usable in practice.	Provide technical support to the local administration in fund raising activities. Reduce the distance between scientific knowledge and practice.	Transform the scientific knowledge in actionable knowledge.
The process of formation of social agency	Lack of awareness of local community toward the role of sanitation in the integrated water cycle.	Dissemination of documents describing the network and facilitation of the access to the monitoring data	Awareness raising about the role of sanitation.
The process of institutional, economic and cultural involvement on innovation	The technicians were unwilling to critically analyse their interventions. They did not accept the innovation. Fragmentation of the decision-making process. Barriers to the innovation.	Trust building between technicians and researchers. Communication among the different decision makers.	Reduction of the distance between scientific community and decision makers.
The process of activation, convergence and concretisation of scientific and technological research	There is an a-synchrony between the time of the decision-making and the time of the research.	Reduce the temporal gap between the two processes.	Continuous monitoring, evaluation and adaptation of the research plan.

2. The debate between technicians and researchers has to be carefully managed. In a cultural-institutional context like the one of the pilot project, the scepticism of the technicians toward the scientific community has to be overcome. To this aim, researchers should clearly state that their work is only complementary to the technical one, and not substitutive.
3. The debate with technicians becomes possible only if the local authority supports the research project.
4. The asynchrony between policy-making and research makes the development of the research plan quite difficult. To overcome this drawback, it is crucial to continually monitor and evaluate the capability of research activities so as to meet the needs of the local community, and to suggest changes to the plan if needed.

FINAL REPORT OF THE PILOT PROJECT IN THE NETHERLANDS

UM: WP6

This text provides a full description of the pilot project in The Netherlands

There is an interesting discussion on the concept of sustainability and on the potential knowledge brokers in the organization. The section devoted to KB tools is also relevant for the guidelines.

The text, as previous ones, is necessary for drafting the guidelines and finding examples.

Based on this pilot project, a description of 'evidences and outcomes' to support lessons learned is already available, which is not included in this document.

Working towards Sustainable Sanitation in The Netherlands

Ragna Zeiss, Onneke Driessen, Olaf Durlinger, Ranjit Pal Singh, Erik Aarden and Wiebe Bijker

INTRODUCTION

A. BESSE

The European Commission is funding the collaborative project 'Brokering Environmentally Sustainable Sanitation for Europe' (BESSE) under the environment sub-theme (Enhancing connectivity between research and policy-making in sustainable development) of the Seventh Framework Programme. The project is a collaborative effort of academic, professional and non-governmental organisations. It aims to contribute to the Renewed, Sustainable Development Strategy of the European Union through the enhancement of the links between sanitation policy and research on sustainable sanitation development. The aims and objectives of the project are:

1. To establish what obstacles are preventing the dissemination of scientific and technical sanitation information;
2. To identify knowledge brokering (communication) methods that will enable the sanitation sectors to overcome these obstacles;
3. To start a learning process on knowledge brokerage in general, as a tool for the socialisation of Scientific and Technological Research (STR).

The project implementation started in June 2009 and

ended in May 2012.

This report reviews the results of Work Package 6 (WP6), the pilot project on knowledge brokerage in sanitation in the Netherlands. Together with the pilot projects WP4 (in Bulgaria) and WP5 (in Italy) it will serve as basis for formulating more general lessons about knowledge brokering to promote sustainable water sanitation.

This pilot project has been carried out by Onneke Driessen (Water Board Limburg, WBL), Olaf Durlinger (WBL), Ragna Zeiss (University Maastricht, UM), Wiebe Bijker (UM), Erik Aarden (UM) and Ranjit Pal Singh (UM) — henceforth in this report indicated as 'the BESSE team. '

B. Water Board Limburg[2]

The Water Board Limburg (WBL, *Waterschapsbedrijf Limburg*[1]) is a public organisation dealing with the treatment of waste water, the transport of wastewater and the processing of sludge.

WBL is funded by taxpayers' money, directly provided by the citizens and industries. Although it is a public organisation, WBL calls itself a company ('*bedrijf*') and works in a more or less business-like manner. Nevertheless, due to its political accountability and social responsibility, WBL and other Dutch water boards—who are responsible for wastewater treatment in The Netherlands—often state that they cannot afford to take financial risks or invest in the same ways that a private company would do. WBL is not a very large organisation, with approximately 150 employees. The majority of these employees have a technical background.

In line with its business-style of management, WBL has formulated a strategic plan for the next five years, and a guide for how to act as a company on the basis of this strategic plan. WBL formulated six strategic goals for the company. These strategic goals are being evaluated by checking 'critical performance indicators'(CPI-s). One strategic goal is, for example, 'improvement of partner (customer and supplier) satisfaction. 'This goal is being evaluated by the CPI' external customer satisfaction '. Through this, we can see that there is willingness to work along private enterprise lines, which is also appreciated by external private partners, and builds a basis for cooperation with them[3]. WBL also aims at building 'the most sustainable wastewater treatment plant in Europe '—a very ambitious WBL is currently in the middle of a transition from the more traditional way towards a more sustainable way of water sanitation. However, this sustainability goal still has a somewhat ambiguous character within WBL.

C. Pilot Project WP6

The main aim of the pilot project was to experiment with knowledge brokerage activities to help WBL's management and workers see the importance of moving beyond traditional design criteria of costs and effluent quality. This knowledge brokerage should then help to develop and implement additional design criteria such as low energy use, low CO_2 emission, and reclamation of raw materials and greenhouse gasses. The aim of the pilot project was thus formulated:

1. To investigate knowledge brokerage activities related to sustainable sanitation within WBL in general
2. To use knowledge brokerage activities to further stimulate 'green thinking ' in WBL, and help to formulate design principles and criteria for a more sustainable water sanitation plant

D. Marble teaching project in Maastricht University

Parallel to the BESSE project, Dr. Ragna Zeiss supervised two research-oriented education projects for highly-qualified bachelor students. Such top students are annually invited to participate in so-called 'Marble ' (Maastricht Research Based Learning) projects. In

2010 and 2011 two groups of social science students investigated various aspects of sustainable water sanitation in and around WBL. The results of these studies have been presented to WBL and to university staff, and were much appreciated. The students' Marble projects have been included in this pilot study too.

DESIGN OF THE PILOT PROJECT

A. The Main Problem

The mission of WBL formulates the ambitions and challenges for WBL in the upcoming five years. The mission states that 'better means sustainable', and argues that sustainability should not be seen as a cost but as an opportunity to decrease costs. Knowledge brokerage on sustainability should then, the BESSE team concluded, provide everyone working at WBL with shared insights on how to work towards realising this goal.

Discussions between the BESSE team and the WBL staff, helped to further identify the key issues of knowledge brokerage on sustainability within WBL:

- The 'What '—what is the meaning of sustainability and what are the consequences of this operationalisation for the brokering process?
- The 'Who '—who are the stakeholders and possible knowledge brokers, and what are their roles and actual influence within WBL?
- The 'How '—how can various knowledge brokering tools be used?
- 'Sustainability thinking' was identified as a change of mind in which sustainability issues such as reduction of energy usage and greenhouse gas emissions become an automatic point of consideration, in addition to the more traditional considerations such as costs and effluent quality. However, integrating 'sustainability thinking' into the daily practices of a company such as WBL is not easy.

B. The Pilot Project

The pilot project was initially designed to concentrate on the incorporation of sustainability in the building of a new water treatment plant. Thus WP6 aimed to help develop a new style of managing sustainable innovation in sanitation. During the process, the focus of this pilot changed and broadened, to also study the incorporation of sustainability in the general strategy of the WBL. During this process, the goal of WP6 was summarised as 'to stimulate green thinking' in WBL.

During the first part of the pilot project an internal WBL workshop was organised with technologists as well as senior management. The aim was to facilitate a discussion about issues such as the importance of sustainability, the awareness of new developments within the organisation, and rethinking the role of the water board within wider society. During this workshop the BESSE team took stock of the 'state' of green thinking within WBL and concentrated on the question of what would be needed, or desired, to improve the embedding of 'green thinking' or sustainability within WBL. This improved 'embedding' of green thinking would help in realising the goal of 'building the most sustainable treatment plant in Europe' and making sustainability 'business as usual'. A workshop report was written and distributed to the workshop participants. The assumption was that the workshop might lead to a more shared concept of green thinking and thus be the first step towards a management model for green sanitation. When indeed this seemed to be the case, everyone was happy. Could knowledge brokerage be so simple?

During the second part of the pilot project, and informed by the workshop, the aim was to select one of three focal points for further knowledge brokerage activities:

1. Develop the idea of green thinking more generally;
2. Develop a model to evaluate sustainability in comparison to other design criteria; and

3. Develop a communication plan to distribute the results of green thinking 'deeper' into the WBL organisation.

The chosen focal point would then be investigated and developed through literature research, interviews[5] with relevant experts outside WBL, and internal WBL workshops. The BESSE team initially decided that the general development of green thinking was at this moment of WBL's development the most pertinent and timely choice. We argued that the general idea of green thinking—taking sustainability into account in all daily practices in WBL—still needed further development to build a strong base for subsequent steps of an evaluation model and a communication model. Towards the end of the pilot project some elements of focal points two and three were also attended to.

Within this aim of developing the idea of green thinking, the core focus then became the so-called 'strategy map' of WBL. The strategy map outlines the strategic goals of the organisation as a whole, as well as the critical performance indicators to achieve these goals. The idea behind the map is that every project and activity will be assessed on the basis of WBL's strategic goals. In order to encourage green thinking and make sustainability a core element of WBL, the BESSE team carried out a sustainability evaluation of the strategic map. A questionnaire was sent to a number of external stakeholders in the Netherlands. The results were summarised in a sustainability evaluation report for internal use by the BESSE team.

In addition, and with participation of the Marble students, the BESSE team investigated how sustainability is currently brokered within WBL. This was done by document analysis and interviews with different individuals and groups in WBL (staff, management, director). Firstly, the BESSE team reviewed current efforts to interpret and evaluate sustainability within WBL and wider literature. Secondly, the role of sustainability in the relations between WBL and its external stakeholders was investigated. This provided insights for developing a communication model with external stakeholders in the future. Thirdly, the role of knowledge platforms for brokering sustainability was investigated. Finally, the Marble project itself—and the implied collaboration between WBL and university—was an experiment in knowledge brokerage and will be discussed as such below.

The various knowledge brokerage actions that were carried out during this pilot study are listed in Table 8.

C. Methodology

The methodology we used in the pilot study is a combination of an ethnographic study of WBL's organisation and community, and an interventionist style of STS (Science, Technology and Society studies) research. This requires a careful balancing of distance (for reflection) and engagement (for intervention). The make-up of the BESSE team (with members from both WBL and university) was such that this balancing act could succeed. Additionally, more standard methods such as conceptual analysis, document analysis, interviewing, and anthropological participant observation were employed.

As a result of this methodology, the findings will primarily be reported in the form of an ethnographic narrative (chapter 3), and then analysed and summarised in a more schematic way.

FINDINGS

This chapter contains the main findings from the pilot study. As the study followed a combination of ethnographic and interventionist STS approaches, these results will come in the form of a narrative analysis of the knowledge brokerage events we organised, and their effects. In the next chapter we will summarise these findings in a more succinct manner.

A. The Concept of Sustainability

One notable result of the pilot project—and indeed central to the whole question of knowledge brokerage in sustainable sanitation—is that the notion of sustainability within WBL is quite varied. The first step in the knowledge brokerage intervention thus was a description and analysis of the spectrum of meanings that WBL staff attributes to sustainability.

When the pilot study began, experiments with new sustainable approaches were already being evaluated by WBL. For this evaluation WBL used standard criteria—such as overall costs and effluent quality—supplemented by new criteria such as energy use, reclamation of raw materials, and decreased emission of CO_2. This combination of old criteria and a new focus on criteria for sustainability created some tension within WBL that will be explored in this section.

On the basis of the observations, interviews and the research within the Marble project, the meanings that WBL employees attach to sustainability by three characteristics: the broadness, the newness, and the importance of the idea of sustainability, were reviewed.

A1. Broadness of the Concept of Sustainability

The concept of sustainability has a range of meanings; some would say that it is rather poorly defined. A. De Man, member of Innovation and Technology Team at WBL, succinctly said that, 'the whole concept of sus-

Table 8 Programme of activities in the pilot project

Knowledge Brokerage Action	Description	Date
'Green Thinking' Workshop WBL	The workshop concentrated on the question of what would be needed or desirable to better embed the concept of 'green thinking' or sustainability within WBL and make it 'business as usual'.	24/02/2011
Workshop report written	Workshop report was written by Maastricht University and added to by WBL.	09/03/2011
Workshop report sent to those who attended the workshop.		06/04/2011
Meeting on WBL's strategy map	A meeting occurred with BESSE and Marble participants in order to explain and discuss the development trajectory, the goals and the (further) process of the strategy map of WBL.	26/04/2011
Marble poster presentations	4 Marble student presented their research plans and methodologies	29/04/2011
Sending out questionnaire for sustainability evaluation strategic map	A questionnaire was sent to a number of external stakeholders (mostly within the Netherlands, but also one of the BESSE project partners with expertise in this area). These stakeholders were asked for a 'sustainability evaluation' of the strategic map.	27/06/2011
Marble final presentations	The 4 Marble students presented the result of their research	11/07/2011
Internal memo on knowledge brokerage for the MDR-concept	Knowledge brokerage within WBL needs more attention and focus, not only on sustainability but more topics, in this memo MDR[4]. A suggestion is made how to broker knowledge following the 'what', 'who' and 'how' approach (see section 2, subsection A: The Main Problem).	11/08/2011
CPI's for the strategic goal corporate social responsibility	All strategic goals in the strategic map of WBL must be converted in (more concrete) critical performance indicators (CPI's) and critical success factors (CSF's), eventually leading to a clear definition of the operational targets. For the strategic goal 'corporate social responsibility ' this has yet to be done. A plan is in progress how to define these goals, the CPI's and the operational targets. The concept of sustainability is a large part of, even partly synonym to, this strategic goal.	October 2011
Workshop on MDR	Resulting from the 11-08-2011 internal memo, a workshop will be held by WBL experts to elaborate the Modular Sustainable Water Sanitation Plant (MDR), particularly by answering the 'what ' question.	November 2011

tainability remains unclear and empty ' (Interview De Man, 05.05.2011).[4] The broadness of the concept inevitably thus often leads to confusion about what sustainability implies. So, for example, T. Houtappels, Manager of the Building and Renovating Team, dis not see a link between the biomimetic approach of cradle-to-cradle and sustainability (Interview Houtappels, 05.05.2011), while J. Janssen, senior advisor to the Building and Renovating Team, considers cradle-to-cradle as one of the main aspects of sustainability (Janssen, 09.05.2011). These contrasting viewpoints illustrate the breadth of the concept itself and the multiplicity of meanings that are being associated with it.

This lead to the issue of specifying a working definition of sustainability, to be used for assessing the sustainability of a project. While some wanted to keep the concept broad and saw no need for a more precise definition (for example, Houtappels and B. Speetjens, Manager of IT and Product and Process Development Team), others emphasised a need for more clarity and precision (for example, De Man and Janssen). In general, the managers seemed to prefer keeping sustainability as a broad concept, while the engineers needed a more concrete definition to allow them to translate sustainability into technical terms.

This discussion about the broadness of sustainability is not only carried out within WBL. A. Balkema, a university researcher, said that 'Engineers often go for green technologies but this is not good enough: green is not sustainable for me, sustainability very much includes the socio-cultural aspects too ' (26.05.2011). Her comments further widened up the criteria for evaluating sustainability by adding another dimension. This pilot project, or the WBL plans for further experimentation in the near future, does not take socio-economic aspects into consideration as criteria for evaluation.

> *Commenting on CO_2 emissions as a criterion, Brigitte Hoffmann, researcher at another university, argued that 'within this whole (process of sustainability assessment), CO_2 is just one thing. If we focus the sustainability work on just CO_2, I think the world would be awful. I mean we really have to unfold sustainable development or living in a sustainable society and we have to unfold this as broadly as possible (...) We have to include things that make sustainable development attractive to people. So, it is not just like saving, reducing or restricting. ' (Hoffmann, 18.05.2011).*

Arguing for a re-interpretation of the notion of sustainability in working environments, Hoffmann points out that appropriating sustainability into everyday work of the organisation would be possible only if the employees are interested in it and when they think that sustainability goes beyond 'saving, reducing or restricting ' to 'excitement and comfort and collaboration and learning ' (Hoffmann, 18.05.2011).

The flexibility in interpretation brought on by the broadness of the concept provided space for negotiating a working definition of sustainability. In the specific context of sustainability assessment this was seen as an asset, since it made it easier to arrive at context-specific definitions of sustainability resulting in a wider inclusion of stakeholders. A. Balkema pointed out that 'the nicest thing of sustainability is that you agree on what you think is important for the situation with the stakeholders ' (Balkema, 26.05.2011). Her comment, apart from ascertaining the validity of the need for keeping the concept of sustainability to be as broad as possible, also provided insights into why the managers did not wish to narrow down sustainability. The breadth of the concept allowed for negotiation on priorities. Though at the same time, it became vague for engineers to operationalise.

WBL is currently investing in the new concept of Modular Sustainable Water Sanitation Plant (MDR: '*modulaire duurzame rioolwater zuiverings installatie*'). This is a new design concept for water treatment plants, in which green and flexible building techniques are combined with shorter depreciation periods to allow incorporation of newly emerging technological solutions. The knowledge brokerage interventions of this pilot project have led to a commitment by WBL to this new modular design style. In November 2011 a high-

level workshop of WBL experts and designers elaborated on this concept, focusing on the concept 'sustainability' and encompassing it into a commonly-shared and action-oriented view of sustainability for WBL.

A2. Newness of the Concept of Sustainability

There is no unanimity about whether sustainability is a new idea. While a few interviewees argued that the concept of sustainability was something relatively new in the building sector (Houtappels, 05.05.2011), others said that sustainability was always an important issue (Janssen, 09.05.2011). This difference in opinion could be understood by pointing to the different roles that these interviewees play within the WBL. While Houtappels as a manager considered sustainability new because it was only recently included into WBL's management plan, Janssen as an engineer always considered aspects of sustainability to be part of the engineering process of building water treatment plants. The differences in their roles within the organisation directly impact on their engagement with the notion of sustainability.

Evaluating these roles in relation to implementation of 'sustainability thinking ' within WBL, Janssen argued that the Management Team should be responsible for providing the employees with knowledge on what sustainability means for WBL and how they should deal with this idea in order to make sustainability an integral part of the organisation's thinking: 'only the managers are in the position to make this concept really clear for us, and at this moment their guidance in making this notion of sustainability pertinent within the company seems to be missing ' (Janssen, 09.05.2011). In contrast, the Management Team did not see itself as a key player in making sustainability an important issue: 'I do not see a role for the Management Team in this regard. No, it is not the task of the Management Team to take the lead (in promoting sustainability)' (Houtappels, 05.05.2011).

Between these two extreme positions, the role of the small group, initially introduced as the promoters of 'sustainability thinking ' within WBL, lacks organisational clarity.

The issue of responsibility for ensuring clarity around the conceptualisation of sustainability is further discussed in detail below, because this responsibility is directly related to knowledge brokerage on sustainability issues within WBL.

A3. Importance of the Concept of Sustainability

The third theme, along which viewpoints in WBL were contrasting, was the importance of sustainability for WBL. While the small group promoting sustainability thinking within WBL attached great importance to sustainability and saw it as a critical success factor for WBL (Durlinger, 2011), other interviewees did not share this enthusiasm. For example, B. Speetjens, Manager of IT and Product and Process Development Team, could only see sustainability as a good thing if it brought in money (Speetjens, 09.05.2011). He argued that sustainability by itself is neither interesting nor important (Ibid.). His view was again partially shared by another manager, who said that sustainability would only be important when it lowered costs (Houtappels, 05.05.2011). This explicit focus on cutting costs was not just a reflection on the priorities of the Management Team, but also showed that sustainability was a relevant factor only if financially feasible to operationalise. Hence, any sustainable alternative to current practices needed to pass the litmus test of financial feasibility.

Within the organisation itself, there were employees who believed that lower costs and increased sustainability during project implementation were not mutually exclusive concepts. According to De Man, there were options in which the cheapest solution was also the most sustainable (De Man, 05.05.2011). However, his research was not being adequately brokered within WBL because he communicated little about his findings. This particular example showcased the potential of knowledge brokerage within WBL.

For a Management Team particularly interested in cutting costs, the research of an employee such as De Man is valuable. The fact that these concepts were not being effectively communicated, thereby supporting the notion of cheaper options also being more sustainable, pointed to problems of information dissemination within WBL. Hence, the next section of this report will focus on the organisational position of knowledge brokers around sustainability within WBL.

B. Potential Knowledge Brokers and their Position in WBL

The end of the pilot project's 'green thinking' workshop, February 2011, produced the following conclusions about the need and direction of knowledge brokerage:

- The small group promoting 'sustainable thinking ' in WBL needed support and commitment from other people in the organisation towards understanding how and why particular choices around sustainability were made, and what their implications for the organisation were. This would eventually prevent the process of designing a new 'sustainable' plant from becoming an unpublicised and poorly recognised project which the majority of WBL employees knew little.
- The employees of WBL should share their knowledge gained while working with a sustainable approach by reporting on that process and exemplifying it as a learning trajectory for WBL. In this way, they should be able to teach WBL colleagues about how to deal with sustainability questions in general, while also showing the concrete translation into designing a plant. This implies that choices need to be explicated and explained in terms of costs, effluent quality and reliability of the treatment process.

Both of these conclusions could be interpreted within the background of a lack of appropriate knowledge brokerage mechanisms within WBL.

The next section focuses on the organisational structure of WBL and evaluates its employees with respect to their potential as a knowledge broker. The employees at WBL are categorised into three groups. Each of these three groups has potential as brokers and they represent different hierarchies within the organisation. Their positions differ in terms of legitimacy, influence and willingness to act as a broker.

B1. Promoters of 'Sustainability Thinking

A small group of people within WBL actively dealt with the concept of 'sustainability thinking'. This group had the strongest position to act as knowledge brokers on sustainability within WBL. The group – still ongoing – consists of Durlinger and Driessen, who are also actively engaged in BESSE. Through BESSE and their own interest in sustainability, they have access to a fair amount of information on sustainability. They have already used their position within WBL to initiate brokering activities and they were crucial in organising the activities of the pilot project.

In terms of organisational influence, this group's position was rather ambiguous. The two senior advisors that constituted the group were relatively high in terms of organisational hierarchy but they could not take operational and design decisions. The decision-making power lies with their supervisors. While they may not have decision-making powers within WBL, they nevertheless were visible and known in the organisation as the people who specifically deal with sustainability. This position could potentially enable them to play a critical role in knowledge brokerage around sustainability issues. As an example, it was observed that most employees knew that Durlinger and Driessen organised the workshop on sustainability thinking and they represented WBL in the BESSE project. However, this position could also have negative connotations: their engagement with and promotion of 'sustainability thinking' could potentially alienate them from the rest of the organisation. For example, several interviewees stated that 'they ' are busy with sustainability issues and 'they ' think it is important (Speetjens 05.05.2011, Spiertz, 20.05.2011).

This led to some ambiguity about who should take the agenda of knowledge brokerage forward in WBL. Some interviewees expressed the view that 'they ' should take up this role because of their clear engagement, while the group itself thought that 'others ' should be more engaged. This contrast in expectations led to organisational inertia in information dissemination around sustainability issues. For example, H. Spiertz, Project Leader of Building and Renovating Team, mentioned that the activities of this group were not communicated within WBL adequately and they remained unknown. He was aware that the group was engaged in a European project on sustainability and also that these two people were promoting the implementation of sustainability thinking, but at the same time, he was unaware of the nature of their activities and did not hear from them about their work (Spiertz, 20.05.2011). Some of these social dynamics were enhanced by the group's good working relationship with WBL's director. This relationship enabled them to effectively broker knowledge to the Director, but at the same time there was some risk of thus increasing the group's social distance to the rest of the organisation. Effective knowledge brokering for all groups seems to require the establishment of (equally) weak ties with all the teams in the organisation.

It is important to underline that the very existence of the two-person group can only be considered a strong asset for enhancing knowledge brokerage on sustainable water sanitation in WBL. The observations about their organisational embedding can hopefully further strengthen their operational effectiveness.

B2. The Management Team as a Potential Knowledge Broker

From an organisational perspective, the managers are in a key position to broker knowledge. They have both the legitimacy and influence to be instrumental in making sustainability a major driving force in decision-making and in making it part of the daily work of the organisation. The management team consists of six members (see Figure 10).

With the Director heading the organisational hierarchy, there are two separate departments that do not have direct influence on the wastewater treatment activities, and there are managers of four departments that are directly responsible for making decisions on wastewater treatment activities. These four departments together shape the way in which ideas are translated into designs and operational practice within WBL. Each of these managers has a team of approximately 15–25 people that do the work in WBL. According to this organisational structure, managers are the key people in WBL who can influence other employees and who have the necessary discretionary power.

While they may have the legitimacy and the power to influence team members of their departments, knowledge brokerage on sustainability was not seen as a priority in the management team. According to R. Ernes, Manager of Operations, the word 'sustainability' was never mentioned during management meetings (Interview Ernes, 10.05.2011). Furthermore, the managers did not seem to be actively engaged in the exchange of knowledge on sustainability outside the management team. The managers did not seem to see their role as being one of knowledge brokering.

This lack of interest seemed to follow from an assumption that knowledge would automatically spread through the organisation (Interviews Speetjens, 09.05.2011; Houtappels, 05.05.2011 and Ernes 10.05.2011). This assumption also fuelled the wish to keep the concept of sustainability rather broad: so that it could adapt to various contexts in the organisation. However, the lack of active engagement by the management team also sent counter-productive signals: one of the employees at WBL commented that 'For me sustainability is a priority.

However, you need to know that the people, to whom you make proposals, share this idea too. And at the moment, I am not sensing this vibe from above, which makes me reluctant to share ideas in this direction. (For the management team,) it is all about costs ' (Interview Van Nieuwenhoven, 24.05.2011). The man-

agers saw sustainability as a task for people enthusiastic about it. In the case of WBL, this would be the promoters of sustainability thinking and some of the team members (Interview Houtappels, 05.05.2011). Therefore, they wanted to keep the notion of sustainability broad and inclusive. They did not think of themselves as the promoters of sustainability within WBL.

One of the major aims of the Management Team was to reduce the costs of operation of their wastewater treatment plants. This was linked to the general belief that sustainable options involve higher costs. The lack of enthusiasm for sustainability was further deepened by the idea that other water companies did not consider sustainability very important (Internal memos during meeting on 23.05.2011). This might explain why many ideas and proposals on sustainability presented to the Management Team did not lead to concrete actions (interview Janssen, 09.05.2011). Janssen gave the example of a workshop on cradle-to-cradle in which one of the team members won a prize for having the best sustainable idea. However, this idea was never picked up by the managers, and is still not implemented. The management team seemed to be struggling with the idea of sustainability. The managers accepted the importance of becoming sustainable, but found it hard to implement and to make it compatible with their cost concerns (Janssen, 09.05.2011).

The Management Team's own rationalisation of their position emanated from the potential of sustainable solutions in the future. Houtappels argued that 'this might be interesting for WBL someday, in the future perhaps ' (Houtappels, 05.05.2011). His view was shared by Ernes who did not prioritise sustainability in his current agenda and confirmed that 'sustainability is on the agenda, but at the bottom ' (Ernes, 10.05.2011). Hence, while the Management Team might be in the strongest position to influence sustainability thinking within WBL, they showed little interest in appropriating the idea.

The group of sustainability promoters was unable to convince the Management Team of the relevance of sustainability. This lack of interest trickled down to the rest of the WBL staff who might personally be interested but did not find the necessary encouragement from their managers. The role of these individual team members is discussed in the next section.

B3. Individual WBL Employees as Potential Brokers

The roles that individual WBL employees can play in promoting sustainability within WBL were generally an extension of their own enthusiasm and position within WBL. Other WBL employees did not have the kind of self-evident legitimacy that the first two groups (discussed above) have. This could be illustrated by the example of De Man who found out that one of the greenest solutions was also the cheapest among the options available. His knowledge was not effectively shared within WBL and De Man's general explanation was that knowledge did not always reach the places it should. He also mentioned that every employee liked to stay within his/her own comfort zone and that knowledge thus remained within a small circle and was not shared with other people within the organisation (De Man, 05.05.2011). He went on to say that 'often it seems as if exchanging knowledge means picking up knowledge. But this is not always the case, especially since at the (present) moment, the knowledge and awareness within the organisation are limited.' Instead, he would want to exchange his insights with the rest of the team because he thought that the current level of knowledge and awareness around sustainability within WBL was limited, and there was just not such 'knowledge to be picked up.'

This problem of effective knowledge management within WBL was not limited to sustainability. Spiertz, Project Leader in Building and Renovating Team, commented that

> *'within this organisation little is being informed or communicated. This creates a lot of double work. For example, quite recently I performed a study that was quite expensive. And only afterwards, I heard that the same research was already done a year before, and thus there was*

no need to perform this study again. So in the end, a lot of money was wasted. And this was not the first time that such double work was done because of bad communication' (Spiertz, 24.05.2011).

Without effective knowledge management in an organisation, one cannot really expect to be able to create a new mind set of being focused on sustainability.

Finally, among the few individual WBL employees who were interviewed, the common observations can be summarised as follows:

1. They did not think of themselves as being in a legitimate position to influence sustainability thinking within WBL.
2. This decreased their willingness to act as a knowledge broker on sustainability issues. This, in turn, did not help the first group of sustainability promoters.
3. To effectively incorporate sustainability thinking in WBL's daily work practices, effective knowledge management was crucial to enable individual team members to share their ideas and research results.

The next section explores the current state of knowledge management practices and the brokering tools that are used in WBL on sustainability issues.

C. Use of Brokering Tools

Two other conclusions from the pilot project's 'green thinking' workshop, February 2011, were the following:

- There was a need for a tool that comparatively evaluates criteria relating to cost, energy use and building material. This should be extended to also include criteria for sustainability.
- There was a need to move beyond the traditional approach with a short-term view to amore long-term future-oriented vision. The sanitation plants needed to be built in such a way that it would be possible to extend and adapt them relatively easily in the future. This meant that present designs should allow for future developments.

Figure 10 Management Team at WBL

These two conclusions point towards the possibility of a new sustainability assessment tool that would be implemented at all organisational levels within WBL, so that sustainability thinking becomes not only part of project planning but also of the everyday operational work at WBL. The various mechanisms currently in place within WBL for knowledge brokerage on sustainability issues are explored in the following sections. These mechanisms include the use of documents to disseminate and promote sustainability issues, workshops and presentations that are used to bring these issues to the forefront and finally a sustainability as-

sessment tool that translates abstract discussions on sustainability into concrete evaluations.

C1. The use of Documents as Knowledge Brokerage Tools

Documents are among the first tools that are used for information dissemination within organisations. Once they are finalised, they provide a certain closure to ideas that until that moment could be rather fluid. One of the important documents within WBL, which also deals with WBL's objectives with respect to sustainability, is the Mission Strategy document. The document not only provides information on the present status of WBL as an organisation, but also envisions the organisation's intended future. During the interviews, the document was mentioned quite often, because it was supposed to direct the actions of WBL employees. In the document it is explicitly stated that for WBL 'better means sustainable' (2010 internal document WBL). It also goes on to mention that sustainability is not seen as a cost, but as an opportunity to decrease costs. This view is not completely owned up to by the Management Team at WBL. This again illustrates how invalid the assumption is that knowledge will automatically spread throughout an organisation: despite the document's being widely accessible to all employees, its views are not shared or lived by, by all employees.

This disparity can be further confirmed from another draft document, which is called the Project Ranking Document. The document proposes projects to be ranked according to certain qualities and requirements, such as cost, efficiency, energy reduction, etc. This document is still in a preliminary stage, but it does indicate the direction in which many of the WBL staff members think about the relative ranking of various criteria. The ranking system is tabulated so that reducing costs gives five points to the project idea while ensuring sustainability only awards one point to the ranking of the idea. At this moment, costs thus rank the highest in importance while sustainability ranks the lowest (Van Nieuwenhoven, 24.05.2011).

Some documents are specifically intended to clarify the notion of sustainability; for example *Op weg naar een Duurzame RWZI* (2008), (Towards a Sustainable Sewage Installation). The document is based on several workshops conducted in co-ordination with the Water Board Delfland, and presents a number of criteria for sustainability. The document, however, is rather descriptive and points towards general guidelines and targets without providing clarity on the criteria for sustainability assessment. Nevertheless, it can be considered a valuable starting point, because it translates general ideas into concrete plans for a sustainable sanitation plant.

Documents need to satisfy two requirements for acting as successful knowledge brokering tools. Firstly, the document itself should be clear, precise and informative. Secondly, it should be so accessible for the intended audience, that they can translate its content into actions. De Man seemed to think that while there were a considerable number of reports, newsletters and notes; most of their knowledge contents went unnoticed and was thus wasted (De Man, 05.05.2011). This view can be corroborated by the experience of distributing a report made to summarise the results of the workshop. Each participant of the workshop was sent a copy of the report, but only one of the participants seems to have read it (Janssen, 09.05.2011). To conclude, the use of documents as knowledge brokering mechanism is rather inefficient, because while the first requirement may be fulfilled as in the case of the WBL Mission Strategy document, the second requirement is currently not being addressed adequately.

C2. Workshops and Presentations

Workshops and presentations are usually intended to garner the interest of the audience towards a topic that can later be reviewed and understood in greater detail through the use of documents. Apart from the activities of the Pilot Project, WBL has been engaged in conversations pertaining to sustainability by using other avenues as well.

Commenting on these workshops in an interview, O. Durlinger, member of the group of promoters and A. Vonken, a WBL innovation engineer, remembered that the first step towards the construction of a model to assess sustainability was taken some years ago by the initiation of several workshops together with the Water Board Delfland. Together with people of different disciplines from Delfland and WBL, a project group was formed to define sustainability criteria. The discussions started with a single question: 'what do you think should be part of a sustainable wastewater treatment plant'? (Vonken & Durlinger, 05.05.2011). The group finally reached consensus on five new and two old criteria. These workshops were organised by two water board companies and the participants were from different disciplines to enable a multidisciplinary perspective during discussions and to avoid 'fixed ' ideas during the brainstorming sessions (Vonken & Durlinger, 05.05.2011).

The agreed-upon criteria were: surrounding, sustainable building, energy, greenhouse gases and resources. The old criteria which had to be included were effluent quality and costs. In the words of Durlinger, they had 'seven criteria and (among) them are five (that) you can read as being sustainable' (Vonken & Durlinger, 05.05.2011).

Employee workshops have been quite a successful strategy at WBL. The employees are generally enthusiastic about participation and they engage in discussions around the ideas on which the workshops are organised. The workshop organised as a part of this Pilot Project is a good example. The problems began after the workshop was completed: while employees engage with ideas during the workshop, they did not seem to own up to these ideas after they returned to their daily routines. Later interviews with workshop participants showed that they thought that while a workshop was a good start, WBL was in need of active knowledge brokers who could pick up, carry and translate these plans. The follow-up research also demonstrated that not everyone in the organisation saw the need to work further on the workshop and its conclusions, while others saw the need but were not sure who should do the work. In general, the interviewees thought that the organisers should come up with follow-up initiatives. On the other hand, the organisers thought that the workshop was aimed at making the participants enthusiastic, so that they would come up with ideas and proposals themselves.

In between these two contrasting viewpoints, the lack of ownership of sustainability initiatives led to a lack of interest in reading the workshop report, lack of enthusiasm around sustainability issues in the everyday work at WBL, and a gradual decrease in noticeable activities that focused on sustainability after the workshop.

C3. Incorporating Sustainability in the Strategy Map

WBL already developed a 'strategy map' (*strategiekaart*) before this pilot project began. The purpose of this strategy map was to help the company management align its vision, goals and concrete actions. One of the BESSE team's interventions of knowledge brokerage was to take this strategy map, and investigate to what extent it paid attention to issues of sustainability.

This intervention entailed four actions (see Table 9), which implied three forms of knowledge brokerage (see Table 10). The backgrounds of the responding experts are summarised in Table 11.

We summarise the most telling answers to the questionnaire[6.]

The most striking reaction, and one supported by 4 of 5 experts, is that the strategy map was not considered very ambitious in its sustainability goals: 'I do not see sparks of sustainability', 'the CPI's are quite traditional', 'the strategy map does not radiate much vision about sustainability'. One expert, though, though that 'the strategy map is a good starting point towards sustainability'.

This observation was linked by several further diagnosing remarks. Two experts made critical observations about WBL's relationship to the outside world: 'I am

missing strategic thinking in terms of the whole water production, usage and treatment chain', and 'the CPIs seem to be shaped by internal company goals, and have too little relationship to external stakeholders'. Another expert stresses that 'sustainability is very much a matter of company culture; it should not be merely a toy of management, but everyone in the company should participate. Moreover, I increasingly recognise how important language is: sustainability is quite abstract and needs translations that people can work with'.

About the concrete CPIs, one expert reminded the team that all Dutch water boards have agreed to certain goals of energy efficiency, sustainable inputs, and a climate plan. These should, thus, come first in any prioritisation of WBL. In addition, he pleaded for allowing for some trade-offs between quality criteria for water and air outputs, which were currently not possible in the CPIs. Balancing between CPIs is important and not self-evident: 'Experience has shown that CPIs are difficult to reduce to a mere number', and thus a more qualitative and dynamic evaluation of CPIs is called for. Another expert explicitly remarked that cost reduction did not necessarily contribute to sustainability, unless sustainability is translated into 'environmental, social and financial sustainability'. The experts critically observed that the five 'pillars' were not explicated in the CPIs. To what extent the five pillars could be realised together, or should be considered partially contradicting, most experts expected no problem. One expert expected most tension to arise in combining the criterion of 'embedding in landscape' with the other pillars. Another saw difficulty in meeting the 'reduction of emission of greenhouse gases' in combination with the other criteria. Another observed that 'the system's boundaries need to be drawn wider than the sanitation plant itself, because the possibilities for synergy within the immediate environment of the plant offer many unused opportunities'.

The strategy map, and particularly the reflection on it as part of this pilot project, does offer opportunities for enhancing sustainable water sanitation. However, it also points to the need for a comprehensive assessment tool to translate sustainability into concrete actions and trade-offs.

C4. Sustainability Assessment Tool

The problem of gradual decrease in noticeable activities that focus of sustainability might be addressed by creating a sustainability assessment tool that could be used while evaluating project ideas for the future. Once such a tool is operational and is deemed necessary for every project conceptualisation, it becomes a part of the everyday work at WBL and the employees would inevitably have to take interest in working with it. Such a tool can be instrumental in making sustainability a part of the everyday conversations related to work between employees.

Despite the fact that one of the major problems in finding sustainable solutions in the sanitation sector is related to the lack of methodologies for sustainable strategic planning and the assessment of sustainability, a tool for sustainability assessment is currently in the making at WBL, driven by the wish to find a way to 'rationalise the green thinking' (De Man, 05.05.2011). The problems again began with a lack of clarity around the notion of sustainability itself. The construction of a sustainability assessment tool is hence seen as an important step to move towards integrated sustainable planning, because at this moment: 'sustainability is not really quantified, and thus the biggest issue is: what is sustainable and what is not'? (Vonken & Durlinger, 05.05.2011). In general, the interviews clearly confirmed the need for a sustainability assessment tool that could provide criteria and guidelines for daily planning processes as well as guidelines for planning the future sustainable sanitation plant in Maastricht.

Among the few successful follow-up activities that emanated from the workshop, a more concrete sustainability assessment model, also called 'Consideration Model' or 'Green Thinking Model', is currently being developed within WBL (De Man, 05.05.2011). It is based on five different criteria, being: effluent quality,

energy, resources, CO_2 emissions and greenhouse gases. Among these, effluent quality and energy are considered to be the two more important criteria. Their importance is largely dependent on the legal requirements WBL has to meet. The effluent quality of the treated water is legally prescribed and there is the *Meerjarenafspraken over Energie*, (Long-Term Agreement on Energy) which demands an annual reduction in consumption of energy from all the water boards.

The purpose of the model is to evaluate and compare design options for different plants. However, the scope of the current version of the assessment model is very narrow and only ways of wastewater treatment and the transport of wastewater have been included into the assessment. Moreover, the current focus is only on the operation process and not on the building and deconstruction. The whole assessment procedure is designed to result in one number and the criteria (use of energy, chemicals and greenhouse gas emissions) are translated and recalculated in terms of an equivalent quantity of CO_2 emissions, based on actual standards and best available information. In a certain sense, sustainability is currently being translated into CO_2 emissions.

When it comes to the anticipated importance given to each criterion, none of the interviewees were able to specify how this would be rationalised: 'nobody knows which criteria are most important' (Vonken & Durlinger, 05.05.2011). However, it was recognised that the interpretation of results and the comparative assessment of criteria was a political process that needed to be done on a higher level of decision-making. As Hoffmann pointed out: 'You might think that such a tool is just about comparing. Of course it is, but it is basically very much about setting an agenda too. (...) It is about paving the way for new solutions by making new agendas. Basically, I think that all of these models—whether people claim that they are based on science, and they might be to some extent—are political tools and they make an agenda. They make an agenda on which direction to take, on what are the important criteria and which are not important, and

Table 9 Actions to analyse the role of sustainability in WBL's strategy map

1.	Analysis of contents of strategy map, identifying elements relating to sustainability
2.	Making a questionnaire about the strategy map 's sustainability elements (see annex 3)
3.	Querying experts in the Netherlands with this questionnaire (see annex 3; 11 sent, 5 returned)
4.	Analysis of response

Table 10 Knowledge brokerage entailed in the strategy map analysis

• The content analysis of the strategy map and the making of the questionnaire by WBL staff and university researchers further helped WBL staff to understand and reflect upon the role of sustainability in WBL's water sanitation programmes
• The answering of the questionnaire by Dutch sanitation experts pushed all respondents to critically reflect on sustainable water sanitation in general and in their local companies in particular
• The response analysis further pushed WBL to think about how its sustainable water sanitation is reflected in the strategy map.

Table 11 Respondents to questionnaire about sustainability in strategy map

J. De Korte	Water Board Delfland
A. Visser	Engineering consultancy firm
R. Overhof	Building contractor
G. Bergmans	Research
H. van der Eem	Engineering consultancy firm

they are very political‘ (Hoffmann, 18.05.2011).

The disagreements around the conceptualisation of this sustainability assessment tool originated with its anticipated complexity in terms of usage. In his interview, Vonken argued for a context-dependent sustainability assessment and said that, ‘it is a utopia to think about one consideration model that works for all the decision making processes: from choosing a pump to building a water treatment plant, I think there need to be different models at different levels‘ (Vonken & Durlinger, 05.05.2011). His viewpoint, however, is not shared by other employees, who prefer a single, very simple model that can be applied everywhere. When De Man was asked if he thought that more criteria should be included into the model, he reacted that it is now ‘already complicated enough‘ and that we need to ‘make (the assessment tool) very, very, very simple‘.

Another aspect of sustainability assessment, which had not been discussed, was the making of trade-offs. WBL is currently busy with rebuilding the treatment plants in Weert and Wijlre. During the planning process the previously-mentioned sustainability assessment model was used. And it was rather easy to implement in the context of these projects. De Man commented that ‘we had one advantage: that the costs and the green thinking went hand-in-hand in these projects, and did not need to be traded off against each other’. His comment showed that WBL partially thought about a strategy when it came to weighing up criteria, communicating results, and handling trade-offs, but that this strategy was not entirely clear and complete yet. It can be assumed that making trade-offs will most likely become more challenging as the number of criteria increases. However, considering the strong focus on reducing costs, the future trade-offs will presumably be made in favour of cost reduction.

Some criticised this strong focus on cost reduction. They argued that usually, ordinary cost-calculations for a product or service did not reflect their full costs: ‘the economic system does not incorporate environmental costs or social costs ‘ (Balkema, 26.05.2011). Choosing sustainable solutions might entail choosing more costly—in a narrow economic sense—solutions. Nevertheless, ‘higher costs for a wastewater treatment system might have additional benefits for society and avoid costs which otherwise would be made, for instance by farmers or people that use polluted water ‘Ibid.). Along these lines, Hoffman argued that inclusion into a consideration model of such additional costs‘ makes visible for businesses and municipalities that this is an attractive development to engage in. In a sustainable project there might be possibilities for making new innovations that in the long term could be very profitable. (...) ‘So you can challenge the cost criteria by putting in other kinds of criteria like innovation, profiling‘ (Hoffmann, 18.05.2011). However, the inclusion of such criteria requires us to move beyond the narrowly technical sphere of sustainability evaluation. And that can be quite challenging as one of the interviewees remarked: ‘I am not sure about the functional, economical and socio-cultural indicators, because that is not really my competence here, not my main job‘ (Vonken & Durlinger, 05.05.2011).

In the midst of the multiplicity of opinions and contrasting viewpoints, this WBL sustainability assessment tool is slowly progressing towards its completion and final implementation. The inclusion of additional criteria is hereby also influenced by the kind of interest that WBL’s stakeholders show in the project. The next section discusses the current stakeholders in WBL and how they might impact WBL operations.

D. The Role of Stakeholders

To ensure that WBL achieves its objective of being actively engaged in sustainability issues and of incorporating these issues into its everyday work, it is not simply the organisation itself that needs a change in mind set. WBL operates within a network of stakeholders that not only provide external support to WBL’s operations, but also influence the way project planning is conducted and ultimately implemented by WBL.

For example, one of the important stakeholders identified during the interviews were the engineering firms. Engineering firms are important stakeholders for two reasons. First, WBL itself is not a technology developer or builder and therefore needs external expertise in implementing any project. Second, the project group of WBL engaged in project planning and implementation may be diverse and multidisciplinary, but they do not have the resources to be up-to-date with all of the potentially interesting technologies in the market. Engineering firms have a much firmer grasp of what is available, although they seem to present an edited list of what is available. Unless the engineering firms are on the same page with WBL on sustainability issues, this edited list would be created around other criteria: for example on cost reduction instead of CO_2 emission reduction. To implement sustainable projects, WBL will eventually require its stakeholders to also be interested in sustainability and to provide information that can enable WBL to achieve its sustainability objectives.

The following conclusion from the green thinking workshop is relevant for this section:

- There is a need for cooperation with colleagues from other Water Boards and engineering firms to learn from each other and share information on sustainability. This can only happen if WBL itself is aware of where it wants to go; that is, for example, WBL needs to be certain about the requirements that different technologies need to meet. In addition, it is important for WBL to communicate and negotiate these requirements with engineering firms and other stakeholders.

  This need of cooperation can only be addressed after a stakeholder analysis to ascertain the external bodies that constitute the community of stakeholders for WBL. The stakeholder analysis presented below is primarily based on an interview with Guus Pelzer, the Director of WBL. There seems to be no structured approach to the identification of stakeholders within WBL. Currently the selection is being done rather intuitively. When asked about the criteria that WBL uses to identify its stakeholders, Pelzer listed the following:

- Ability of the stakeholder to influence the Critical Performance Indicators (CPIs) either directly or indirectly (preferably directly): This criterion implies the exclusion of the general public as stakeholder, as they can only influence the CPIs indirectly.

- Being the 'best in class': WBL as an organisation only cooperates with partners that are the best in their segment. Next to the obvious advantage in quality of services when cooperating with the best actors in their respective fields, it also provides leverage to WBL against other companies.

- Ability to reduce costs for WBL: This becomes an important criterion in the choice of suppliers and engineering companies as stakeholders.

- Ability to create value for WBL: This criterion primarily informs the nature of the relationship between WBL and the external partner. Trust and mutual co-dependence are considered to be important factors in evaluating this criterion.

Following the logic of these criteria, the most important stakeholders that Pelzer identified are suppliers, engineering companies and the water boards. Furthermore the private companies Veolia, as a partner for cooperation, and Sappi, as partner as well as client, were named. The criterion of being the 'best in class' qualifies Veolia to sit at the stakeholder table as they are world leader in wastewater treatment. When probed further and asked if there might be more, the municipalities were also admitted into the circle of important stakeholders. On the other hand, Pelzer excluded the public from being a stakeholder in WBL. The director's analysis was mostly confirmed by other employees of WBL. Hence, it seems to be a consensus within the organisation that general public is not a stakeholder in WBL. When asked if there may be circumstances that could force WBL to consider an external body as a stakeholder, Pelzer dismissed the idea.

CRITICAL ANALYSIS: TO ALLOW COMPARISON WITH PILOT PROJECTS WP4 AND WP5

The excellent performance of WBL over the years has enabled it to have control over its choices for stakeholders.

One of the strategic goals for fulfilling the Critical Performance Indicators (CPIs) in WBL is the improvement of partner (customer as well as supplier) satisfaction. Municipalities are the customers for WBL; engineering firms and material suppliers are in the supplier category. Hence, it becomes imperative for WBL to not only maintain business relations with its partners, but also to impress upon them the organisational ideology of WBL, for example about sustainability. Without this, partner satisfaction would be difficult to achieve. Hence, a Communication Model has been planned after this Pilot Project to facilitate better cooperation between stakeholders and WBL. The combination of the business aspects of renovation, extension and construction of wastewater treatment plants and a focus on sustainability requires a new communication approach with external stakeholders, specifically engineering firms and technology suppliers. This Communication Model is currently under development and would be an important achievement towards creating a network of organisations interested in pursuing sustainable solutions with WBL as a hub for this network.

Several aspects of communication with stakeholders have been identified as important when creating this Communication Model. First, the green thinking workshop concluded that wastewater treatment plants need to be built in such a way that it is possible to extend and adapt them relatively easily in the future. This kind of flexible design requires a new way of communicating with external technology providers as well as customers. Secondly, sustainability should not be thought of as only a characteristic of the treatment plant itself; it also should characterise the organisation. In this sense, WBL wants to be a socially responsible 'high performance organisation' and considers holding its partners to similarly high standards. Hence, the view of WBL needs to be disseminated through its network of stakeholders, and ideally every node in this network should actively participate in achieving sustainability standards. Thirdly, these aspects should influence with whom WBL does its business, and therefore sustainability and flexible design should become a part of the tendering process.

This section goes beyond WBL as an organisation to place it within the network of stakeholders with whom it is engaged with at a regular basis. Promoting sustainability is seen as an inclusive process that starts at WBL itself and then spirals into the other organisations that are connected to WBL. While it might be idealistic to expect that the stakeholders will also be as enthusiastic about sustainability issues as WBL, the setup of the Communication Model is a step towards getting the entire network of WBL on board. The success of the Communication Model can only be evaluated in the future, but it offers a good starting point in making sustainability thinking not only an everyday routine at WBL, but also ensuring that the stakeholders focus on sustainability thinking too when working with WBL.

CRITICAL ANALYSIS: TO ALLOW COMPARISON WITH PILOT PROJECTS WP4 AND WP5

The aim of this section is to illustrate the potential of knowledge brokerage activities in addressing the problems previously highlighted. As part of the critical analysis, the BESSE partners devised a map of hindering and facilitating factors as a model of a techno-scientific innovation cycle, in order to properly place each of the factors within a general picture. Interpretation of this model will be used to showcase the potential places of individual knowledge brokering activities being experimented with in WBL. The model showcased four social processes, which can be summarised in the context of WBL as follows:

- **The process of transformation of new knowledge**

into technological innovation: This process implied identifying items that are potentially exploitable in terms of applications and technologies within a given sector and their diffusion. In the specific context of WBL, the focus was on items that could potentially encourage appropriation of sustainability within the conceptualisation of new water treatment plants and renovation of plants which are already functional. The work being done on developing a Strategy Map for WBL with a formalisation of Critical Performance Indicators (CPIs) could be seen as exemplifying this process. The Strategy Map will eventually help in the identification of new technologies and processes that reflect better on the CPIs and hence, are more attuned to the WBL's organisational focus on sustainability.

- **The process of formation of social agency:** This process refers to promoting dialogue and a relatively stable interaction among all the stakeholders on the identified items to enable policy formulation. While the research work done on knowledge brokerage in WP4 and WP5 comprises of multiple stakeholders across the domain of implementation of sanitation technologies, the work was directed towards an organisational study of WBL. Hence, the stakeholders in this particular case are the employees of the WBL and their respective interest and conversations in the domain of sustainable sanitation.

- In the context of promoting a stable interaction among WBL employees, the process of creating and standardising Sustainability Assessment Tool can be interpreted to represent this process. This tool helps to ascertain the role that sustainability could potentially play within WBL in terms of project planning;, it also helps to clarify the concept of sustainability as a means to address the diverse interpretations of its meaning for the organisation. The diversity of knowledge brokerage practices that could be used to encourage dialogue between employees could also be seen as a part of this process. For example, the dissemination and perusal of documents such as the Mission Strategy document is a potential vantage point from which such stable interactions could be promoted. Workshops and presentations are another avenue for understanding this process at work.

- **The process of institutional, economic and cultural involvement on innovation:** This process goes beyond WBL as an organisation into its external stakeholders to promote techno-scientific institutional and cultural involvement for innovation on the identified items. Engineering firms could be seen as important stakeholders for WBL because, unless they have a similar understanding of the importance of sustainability as WBL, their formalisation and listing of resources that WBL can access for implementing any project will be based on different criteria such as cost reduction instead of minimising CO_2 emissions. Hence, to implement sustainable projects, WBL will eventually require its stakeholders to also be interested in sustainability and to provide information that can enable WBL to achieve its sustainability objectives. It is also imperative to understand that engineering firms are only one aspect of the spectrum of stakeholders that WBL identifies itself to be associated with. Hence, in this respect, the development of a Communication Model towards creating a network of organisations interested in pursuing sustainable solutions with WBL as a hub for this network could be seen as an example of this process.

- **The process of activation, convergence and concretisation of scientific and technological research:** The final process in this model connects back to the first process to complete a full circle of knowledge brokerage practices. This process implies an over-all culmination of scientific and technological research brought about by expansion of the network of stakeholders in Process 3 to create new items that could potentially be identified and disseminated via Process 1. There is a belief that the knowledge will automatically spread through the organisation once it is accessible by its employ-

ees. However, it is also clear that knowledge does not always reach the places it should. The general impression was that every employee likes to stay within his/her own comfort zone and knowledge thus remains within a small circle and is not shared with other people within the organisation. This situation is a rather systemic problem that does not have a single solution. An appropriate operationalisation of the three processes mentioned above could be seen as a starting point to the creation of an organisational culture wherein new ideas around sustainability are encouraged and shared between employees. A potential way of approaching this problem could be seen in the formalisation of the Project Ranking document wherein sustainability is given the same standing as cost reduction for project ideas. But, currently the document shows a lesser value associated with sustainability as a factor in evaluating in new projects as compared to cost reduction. Hence, while one may still consider the document to be a place where new project ideas are discussed, it cannot be used as a concrete example of the efforts directed towards sustainability. Though, a simple redefinition of the value attached with the factors on which projects are evaluated could be helpful in promoting sustainability. The work done in the other three processes will play an instrumental role in creating possibilities for discussions on new ideas and new avenues for techno-scientific research.

Figure 11 Model of the cycle of techno-scientific innovation with WBL as a case study

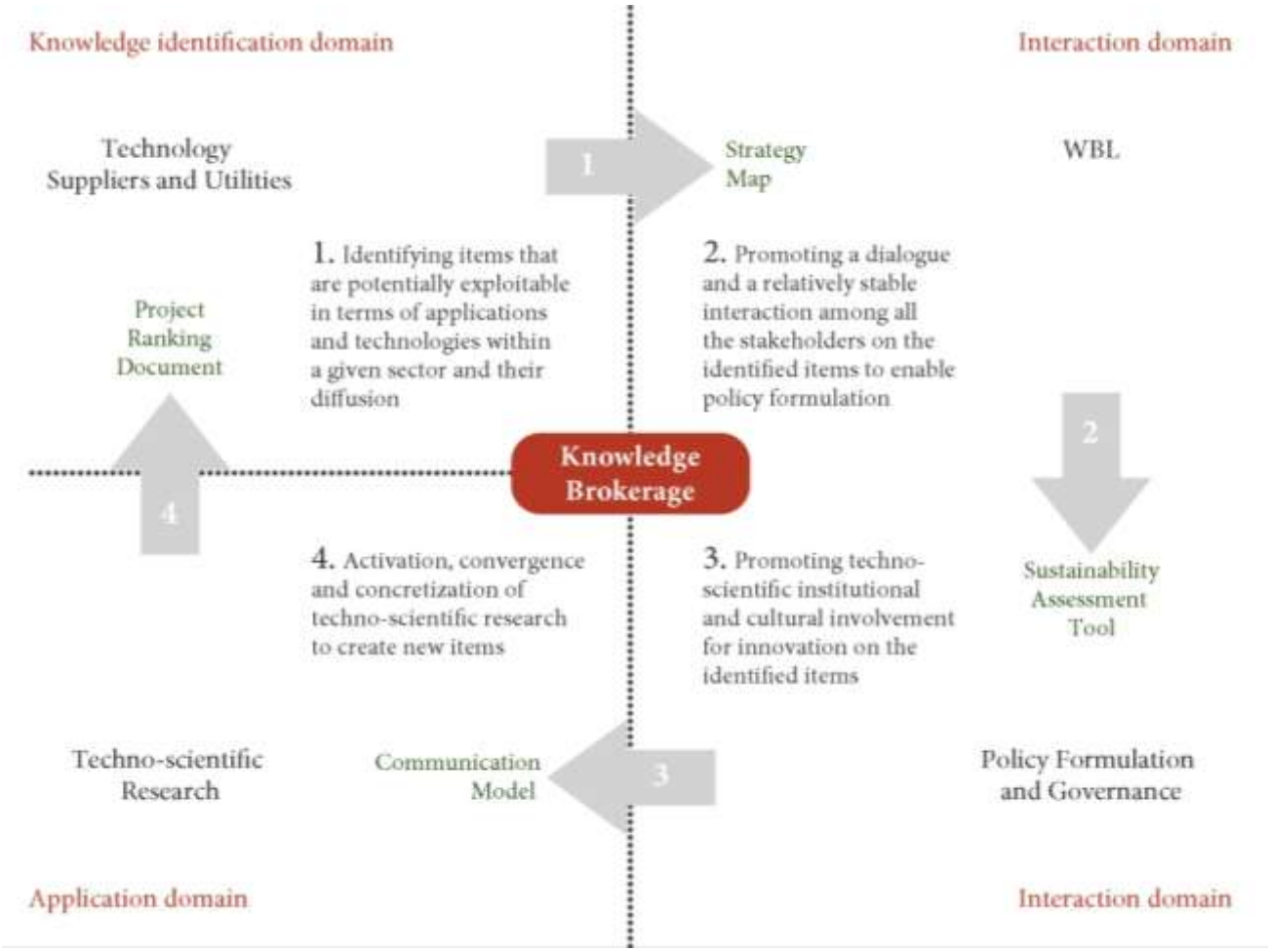


Figure 11 illustrates the interpretation of the model

based on WBL as a case study.

Since the study is based in the context of WBL, these processes are embedded within the organisation itself and the hindering and the facilitating factors for all of these processes have an organisational character. These factors apply to all the processes and cannot be categorised on the basis of individual process.

A. Hindering Factors

Among hindering factors, the following require critical attention.

A1. Idea Killers

Within organisations one can generally identify the reasons around lack of creativity and innovation in terms of specific sentences used in conversations. Gleaned from from the interviews illustrate the ambiguity on the importance of sustainability within WBL:

- 'Not my responsibility'
- 'That's in the plan for the future'
- 'Not enough resources' or 'No budget'

Each of these sentences showcased a way in which an idea could be discarded without exploring its complete potential. If sustainability was to become an integral part of WBL's organisational culture, such views could only be taken into consideration after the full potential of an idea had been discussed and communicated. This could potentially enable employees to come out of their comfort zones and discuss ideas more freely than occasional workshops on issues.

A2. Lack of Clarity on Sustainability

Previous sections already illustrated that the notion of sustainability within WBL is quite varied. Hence, the first step in the knowledge brokerage intervention was a description and analysis of the spectrum of meanings that WBL staff attributes to sustainability. This lack of clarity is a hindering factor in all the social processes discussed before, whether it is the creation of a strategy map, a sustainability assessment tool, a communication model or a project ranking document. While it may seem necessary to keep the concept broad for a context-specific re-evaluation at a management level, the concept needs concrete parameters at an operational level. Maintaining this balance is a critical factor for success in projects that focus on sustainability.

A3. Lack of proper communication mechanisms within WBL

Information exchange and knowledge management were cited at all hierarchical levels within WBL as a problem. Whether it is Management Team members who say that they have a limited understanding of the nature of the activities conducted by the team promoting 'sustainable thinking' in WBL, or it is individual employees who report instances of double work and unread documents; the problem seemed to be embedded in a lack of communication. This problem could potentially hinder the efforts with respect to all the knowledge brokerage practices because all of them require a shared understanding of sustainability at an organisational level.

B. Facilitating Factors

Among facilitating factors, the following could be considered as especially important:

B1. Access to a Multi-disciplinary Team and Varieties of Expertise

WBL already has access to a multi-disciplinary team with members having expertise in various aspects of wastewater treatment plant. Though WBL is not a technology developer, it has enough in-house expertise to evaluate options in terms of sustainability. This is a potential asset because it allows WBL to play a critical role in defining and regulating the scope of its interest in sustainability and making external stakeholders align towards its goals. It also enables WBL to have a managerial perspective on the viability of incorporating sustainability in project plans and also an operational per-

spective, through its engineers, to include sustainability into the design of the plant and its functioning.

B2. Presence of a Team focused on Promoting 'Sustainable Thinking'

The presence of a team that specifically focuses on sustainability issues is an asset because it represents that WBL has an explicit focus on the issue. The team can provide opportunities for active knowledge brokerage practices directed specifically towards sustainability and could play a pivotal role in changing the organisational culture of WBL. There are some issues of responsibility that need to be resolved in this context and there is a need to match the expectations of this team with the expectations of the rest of the employees, but, the research has enabled these issues to come out in the open, so that they can be appropriately addressed.

B3. Enthusiasm towards the Possibility of Incorporating Sustainability within the Organisational Culture of WBL

There were some contradictions with respect to the nature of enthusiasm shown by the employees of WBL towards sustainability. If their participation in the workshop organised on 'green-thinking' was considered, the atmosphere was certainly very positive and there were critical discussions on how to incorporate the notion of sustainability in the 'business-as-usual' of WBL. But, after the workshop, the level of enthusiasm could not be maintained. In this respect, cognisance should be taken of the various activities that were initiated within WBL as illustrated in the model of the cycle of techno-scientific innovation to be indicative of the enthusiasm that the organisation showed towards sustainability. Taking all of these initiatives into account, WBL has been proactive on its mandate of 'better means sustainable' (2010 internal document WBL) and the lack of enthusiasm shown after the workshop should be attributed to the lack of proper communication mechanisms within WBL. This enthusiasm is the foundation of any knowledge brokerage activity because exchange of information is based on the level of interest towards the activity among participating entities.

CONCLUSIONS

Three action domains for knowledge brokerage were identified:

1. **Knowledge identification domain.** In this domain, knowledge brokerage is aimed at identifying, being selecting and organising, among the available knowledge, those items potentially exploitable in terms of applications and technologies within a given sector (in this case, that of sanitation).
2. **Interaction domain.** In this domain, knowledge brokerage is aimed at creating a relatively stable, meaningful and effective interaction among players who play or should play a role in exploiting new knowledge.
3. **Application domain.** In this domain, knowledge brokerage is strategically aimed at 'implementing' the new knowledge that is, contributing to transforming it into concrete innovation of any nature (definition of new norms, activation of new research projects, application of new knowledge and technologies, etc.).

The BESSE team actively engaged in the WBL activities on sustainability by carrying out several experimental knowledge brokerage events spanning across the three action domains mentioned above. This produced a rich understanding of the current state of sustainability thinking in WBL, the strengths and weaknesses of various knowledge brokerage mechanisms, and some concrete contributions to the WBL work on sustainability. It can be observed that the social processes of knowledge brokerage activities fall into individual action domains as previously illustrated.

In conclusion, the following remarks pertain to some general insights on knowledge brokerage within the organisational culture of WBL.

- The first step towards effective knowledge brokerage is to understand the context within which it is to be implemented. Understanding the organisational culture of WBL and the problems that concern it significantly changed the scope of the pilot project and its intended results.

- Organising a workshop may be a good starting point for conversations on a particular theme such as sustainability, but a plan for a set of follow-up activities to ensure continuous presence of the theme in everyday conversations within an organisation will eventually help in overcoming the initial inertia of discussing and engaging with the theme.

- Simple activities that encourage conversation go a long way in demystifying unclear concepts. The interviews with WBL employees on their opinions around sustainability enabled us to change the focus of the pilot project on creating a shared understanding on sustainability itself. We realised that in the absence of such an understanding, the initial conceptualisation of a pilot project focusing on the incorporation of sustainability in the building of a new water treatment plant would not have yielded fruitful results.

- Knowledge brokerage activities usually have a snowball effect, if they are focused on a smaller community. Since we focussed on a single organisation with strength of approximately 150 employees, it was easier to discern the results of the activities and evaluate the next steps in the process. To cite an example, the pilot project that was started as a way to stimulate 'green thinking' in WBL, eventually led to work on development of a Communication Model between WBL and its external stakeholders to create a network of organisations interested in pursuing sustainable solutions with WBL as a hub for this network.
- There is a difference in managerial and operational aspects of sustainability. An acknowledgement of

ANNEX

Table 12 ANNEX: List of Interviews

Interviewee	First Name	M/F	Function and Affiliation
Balkema, A.	*Annelies*	F	Associate Professor (Technical University, Eindhoven)
Driessen, J.M.C.	*Onneke*	F	Senior Advisor Quality and Cooperation (WBL)
Durlinger, O.L.C.	*Olaf*	M	Senior Advisor Wastewater Infrastructure (WBL)
Ernes, R.M.A.	*Rob*	M	Manager Operations (WBL)
Hoffmann, B.	*Birgitte*	F	Associate Professor (Technical University of Denmark)
Houtappels, A.L.J.	*Twan*	M	Manager Building and Renovation (WBL)
Janssen, J.P.M.	*Jan*	M	Senior Advisor W&E (Mechanical and Electrotechnical Engineering; WBL)
Man, A.W.A. de	*Ad*	M	Senior Engineer (WBL)
Nieuwenhoven, C.H.J.M. van	*Cor*	M	Advisor High Performance (WBL)
Pelzer, E.M.	*Guus*	M	Director (WBL)
Speetjens, H.A.M.	*Bert*	M	Manager IT, and Member Product & Process Development Team (WBL)
Spiertz, H.M.J.	*Henri*	M	Project Leader Building and Member of Renovating Team (WBL)
Vonken, A.P.M.	*Andries*	M	Innovation Engineer (WBL)

this difference and its incorporation into the design of strategy map and sustainability assessment tool would certainly help in clarifying the meaning of the concept to employees with different expertise.

- Encouraging new conversations on sustainability needs an understanding of the restrictions that idea killers pose.
- Finally, a setup of an effective communication mechanism is essential to any knowledge brokerage activity. While there are many kinds of knowledge brokerage activities that may be carried out, only a few of them would eventually have results that would align with their intended goals. An iterative understanding of what works and what doesn't work through trial and error is essential to knowledge brokerage.

LIST OF EMERGING LESSONS AND OUTCOMES

UM: WP7 based on steering committee meeting deliberations

This is the first formulation of the emerging lessons and outcomes as they were developed in the framework of the Steering Committee Meeting held in Rome on October 2011.

LESSONS AND OUTCOMES

- Systemic approach important
- Scale at which brokerage applied
- Knowledge brokerage: valued added?
- Brokerage renewal and iterative
- Public awareness – cultural, local
- Two-directionality (supply and demand)
- Element of demand needs articulating
- Actionable knowledge (= reworking of 'supply')
- Incentive structure
- Trust building
- Character of knowledge
- Lessons learned for each organisation
- Built-in reflexivity
- Scope of KB is broader than standard interventions
- KB is not magic bullet
- Stakeholder involvement: cross-cutting theme; to be specified and organised in specific ways

ELEMENTS OF ENVIRONMENTALLY SUSTAINABLE SANITATION

- Sanitation is in a state of inertia
- Political-cultural neglect of importance of sanitation
- Sanitation typically is too invisible

WEDC: WP7 based on steering committee meeting

This text is a first organisation of the emerging lessons and outcomes as they were developed in the framework of the Steering Committee Meeting held in Rome on October 2011. The text also includes the grid to be applied for drawing evidence from each pilot to support the lessons learned.

This text is a preliminary work to the document on lessons learned from the pilots that WEDC is still develop-

ing. Both the former and the latter may be useful in order to set up structure and contents of the final guidelines.

SUMMARY

This chapter is a follow-up to the meeting in Rome in October 2011 and explains the next steps in the process of drawing knowledge brokerage (KB) lessons from the case studies we undertook in Pernik (Bulgaria), Castel Sant'Angelo (Italy) and WBL (The Netherlands). The report starts with some background information for context.

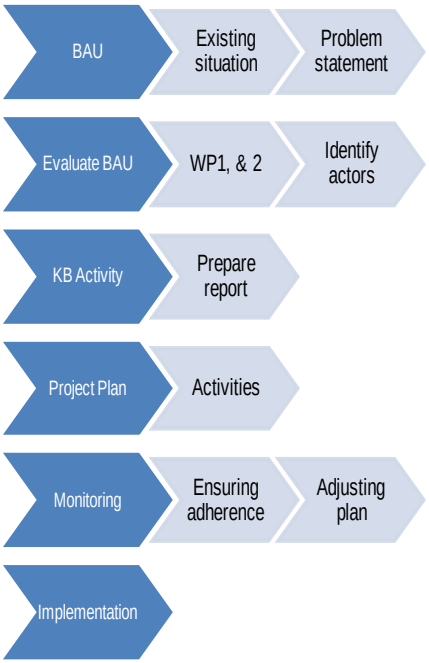
In the second section, it attempts to define KB in such a way that describes what the BESSE project did. This will be necessary so as to place the wider Lessons Learnt report into context. The third section considers how lessons can be drawn from the case studies. It explains the rationale for the proposed process. Finally, in section four, the actual steps that each of the case study authors will need to take in extracting lessons and give a worked example of how to present the information.

Background

The BESSE project is now completed through the implementation of six work packages, which provided supporting material to frame the project's findings in the form of policy guidelines. The description of work states that the policy guidelines document will include a position paper summarising the technical and methodological knowledge brokerage lessons learnt during the project. The core of the lessons are drawn from the three case studies undertaken in Castel Sant' Angelo (Italy), Pernik (Bulgaria), and WBL (The Netherlands), as well as the background work done by the research partners. Hence, the three case studies were built around a template to facilitate lesson learning and aid comparability (see Figure 12).

This note focuses on the initial steps undertaken to identify and extract lessons from the research we have done in the case studies.

Figure 12 BESSE Strategic Set-Up Grid



KNOWLEDGE BROKERAGE

Two questions need to be answered in the first instance:

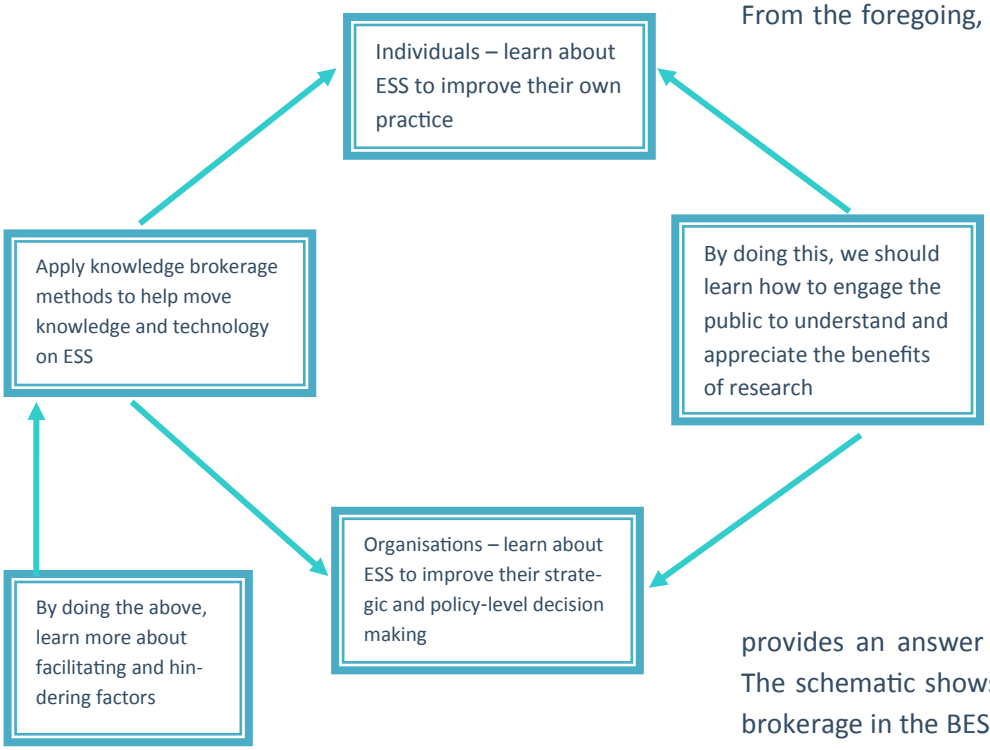
1. What do we mean by knowledge brokerage in the BESSE context? and
2. What was the research aim of the BESSE project?

Prof W. Bijker identified the following text relating to

knowledge brokerage in the proposal.

KB is referred to as a process - helping to move knowledge and technology from one place to another in order to help individuals and organisations to learn and improve.

Figure 13 Knowledge brokerage and project aim framework



Alongside this, KB methods in the BESSE context (are meant) to overcome (…) hindering factors and to maximise the exploitation of knowledge relevant for Sustainable Development.

Unpacking the above, the following constructs emerge:

- Movement of knowledge and technology;
- Factors that facilitate or hinder this movement;
- Individuals and organisations as recipients;
- Learning for improvement; and
- Sustainable development as the overarching context.

The proposal also states that the project intended to:

'start up a learning process on knowledge brokerage in general, as a tool for the socialisation of Scientific and Technological Research (STR) '.

We interpret this as meaning: learning how to use knowledge brokerage methods to engage the public to understand and appreciate the benefits of research.

From the foregoing, we can develop a framework that provides an answer to the questions outlined above. The schematic shows 1) what we mean by knowledge brokerage in the BESSE context and 2) what the project did – the project aim.

We have the following:

- We did activities to move knowledge on environmentally sustainable sanitation (ESS). These activities were, collectively, knowledge brokerage;
- The knowledge brokerage led to individuals learning about ESS to improve their practice;
- The knowledge brokerage led to organisations improving their strategic and policy-making capability; and finally
- By engaging in knowledge brokerage we should draw lessons about how to implement public engagement***

Notes:

- The above framework relates to the overall project

and stands separate from the individual case study aims;

- Thus, we should fit the lessons we learnt to this framework;
- We will present the individual case study reports or summaries as appendices to WP7. This is important because the lessons will only be 'believable' if the evidence supporting their formulation is available;

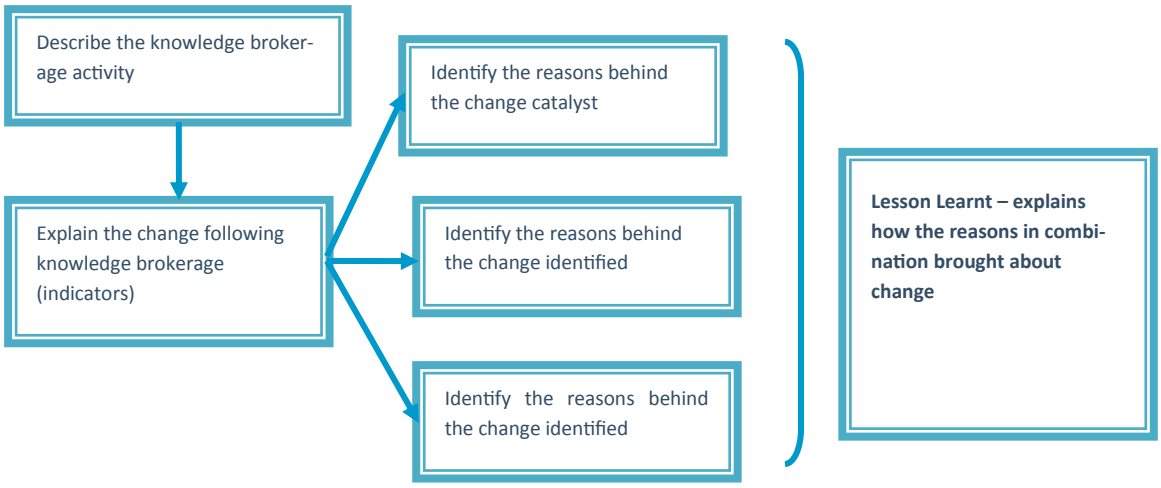
*** It is not clear from the description of work, how we should report this learning process; there is no deliverable relating to it. Perhaps we should also identify lessons on doing public engagement.

DRAWING LESSONS

In effect, the starting point for identifying lessons will be identifying the changes brought about by the knowledge brokered in each of the cases studies. Once we have identified these changes, we can then distil the reasons for the change – the things that enabled the changes as shown in Figure 14. The three boxes illustrate that there may well be more than one reason contributing to any one change.

We would then take this information from all three case studies and do a meta-analysis to begin to identify universal knowledge brokerage lessons. We will do this by mapping the case study information across to the list we began to develop in Rome, which we present below.

Figure 14 Drawing lessons



A. List of potential lessons identified during Rome meeting

- Systemic approach important
- Scale at which brokerage applied
- Knowledge brokerage: valued added?
- Brokerage renewal & iterative
- Public awareness – cultural, local
- Two-directionality (supply & demand)
- Element of demand needs articulating
- Actionable knowledge (= reworking of 'supply')
- Incentive structure
- Trust building
- Character of knowledge
- Lessons learned for each organisation
- Built-in reflexivity
- Scope of KB is broader than standard interventions
- KB is not a magic bullet
- Stakeholder involvement: cross-cutting theme; to be specified and organised in specific ways

After reviewing this list at WEDC, We realised that though useful, the list would be better if clustered to

group similar ideas. Clustering produced the following amended list.

B. List of potential lessons clustered

- Statement of value added by KB: what was there at the end that was not there at the outset?
- Identify and give evidence for the presence of the following catalysts for KB
- Importance of adopting a systemic approach to KB:
- Two-directionality (supply & demand)
    - Incentive structure
    - Element of demand needs articulating
    - Identifying actionable knowledge (= re-working of 'supply')
- Character of knowledge (difficult to define/pin down??)
- Scope of KB is broader than standard interventions
    - Scale at which brokerage is applied
    - Brokerage renewal & iterative
    - Built-in reflexivity
    - Includes Public awareness – cultural, local
- Stakeholder involvement: cross-cutting theme; to be specified and organised in specific ways
    - Identifying relevant stakeholders
    - Trust building

WEDC used this clustered list to draw lessons, and then categorise the lessons, as applying at either an *individual* or an *organisational* context in line with Figure 13.

This section describes the actual steps each of the case study authors took to extract lessons and provide examples of how to present the information. Once this exercise was completed, the WEDC team completed the next step, which was then consolidated to extract the lessons.

Partners were requested to prepare an activities matrix for their own case study using the format of the table below. It was important to include activities from which the result may have been negative as this has been an important part of the learning process that could led to subsequent activities that have positive results; this is clearly illustrated below:

Table 13 Format for KB activities for each case study

KB activity	Significant change/ result	Key factors bringing about change/result

The WEDC team then merged these into a master list. To make this easier to understand, they provided two worked examples.

The first example comes from the report of the Castel Sant' Angelo case study.

A. Example from Italy

Extract of original text from Section 3 of the Castel Sant' Angelo Report:

'Firstly, the main actors concerned with the management and maintenance of the sanitation system - i.e. the local authorities, the technicians and the water management agencies – where involved in a communication exercise. In the early stages, the communication between the BESSE team and these actors was hampered by some obstacles. Although the municipality of Castel Sant'Angelo is part of the BESSE consorti-

um, the willingness of the local authority to take part in the discussion with BESSE experts was rather low. According to the experience, this was mainly due to the inherent difficulties to critically analyse their approach to sanitation system management. In the early stage of the project implementation, the local authority considered extremely reliable the intervention made on the main collector of the sewage network, and the willingness to discuss it was rather low. This negative attitude drastically changed when a direct contact was established between the local authority and the scientist working on the design of sewage network. The debate among scientists and authority identified monitoring of the network as the most urgent intervention required by the authority.

Although the communication with the authority dramatically improved, it did not prove unproblematic and the main barriers were the lack of trust toward the scientific community. This barrier was overcame by supporting the dialogue between technicians and scientists and making clear that the aim of the project was not to formulate a judgment on the different interventions carried out on the network.

The last actor involved in this phase of the BESSE implementation was SOGEA, the water distribution management company. The communication with this actor was hampered by the lack of trust toward the local authority. This was because SOGEA was not involved in the design and implementation of the intervention on the main stream of the network and because they showed no interest in knowledge brokerage at the start of the process. Their attitude changed when the idea of the monitoring system was proposed by the BESSE team and the scientists and they agreed that the collected data could be prove useful to support them in the management of the whole sanitation system.'

The relevant information was mapped from the abstract above into the table below, using the format set out in Table 16. Note: for the purposes of this example, the text has been extracted verbatim to illustrate that no interpretation layers were added; it is a true represen-

Table 14 Example of data extracted from Castel Sant'Angelo text in proposed format

KB activity	Significant change/result	Key factors bringing about change/result
• Communication exercise: the local authorities (LA), the technicians and the water management agencies.	The willingness of the local authority to take part in the discussion with BESSE experts was rather low.	This was mainly due to the inherent difficulties to critically analyse their approach to sanitation system management.
• Direct contact was established between the local authority and the scientist working on the design of sewage network.	This negative attitude (of the LA) drastically changed. The communication with the LA dramatically improved.	The debate among scientists and LA identified the monitoring of the network as the most urgent intervention required by the LA.
• Communication with the technicians involved in the network management.	Communication was not easy.	The main barrier was the lack of trust toward the scientific community.
• Supporting dialogue between technicians and scientists.	This communication barrier was overcome.	The dialogue between technicians and scientists made clear that the aim of the (BESSE) project was not to formulate a judgment on the different interventions carried out on the network.
• Communication with SOGEA.	Communication was hampered by the lack of trust toward the LA	Because SOGEA was not involved in the design and implementation of the intervention on the main stream of the network. At the start of the process they were apparently not interested in knowledge brokerage.
• BESSE team and the scientists proposed the idea of the monitoring system.	SOGEA's attitude changed (to be more positive).	They agreed that the collected data could be really useful to support them in the management of the whole sanitation system.

Table 15 Example of data extracted from WBL report in proposed format

KB Activity	Significant change / Result	Key factor bringing about change /Result
Meeting between WBL management and technicians to discuss sustainability within WBL.	Got agreement to go ahead with sustainability focus.	Sustainability is in WBL's mission and management is accountable to the Board therefore, spurred to action – must define a sustainability strategy. Discussions uncovered that real opportunities exist to advance sustainable operations within WBL.
Meeting between BESSE team and Marble participants to receive inputs for strategy development.	Agreed on a plan for taking the WBL strategy forward.	A growing realisation by the BESSE team after meeting with management that BESSE would have to provide leadership. Marble student presentations clarified gaps for the BESSE team.
The above led to interviews with management to discuss sustainability and a 'green' approach.	Scale of challenge in adopting a sustainable approach revealed.	Management owns WBL's sustainability focus as their responsibility.
Developed a communication plan.	Staff buys into the sustainability agenda.	A range of sustained communication activities including presentations, memos, etc. persuade staff to consider sustainability: Presentations by Marble students; Distribution of literature and relevant documents; Meetings and workshops.

tation of the key KB activities set against the results/ change and the giving the reasoning/evidence for the change.

The second example comes from the WBL case study. This example shows how one could do the same without relying on verbatim text. Thus, reading between the lines, we have teased out from the pilot project report, a series of KB activities with corresponding changes and reasons for the changes.

B. Example from WBL

We expect that to do this, one would rely on both verbatim case study reports and one's own knowledge. To work, these matrices need to be as detailed as possible and record all KB activities that took place (in the first column), the significant changes that came out of those KB activities (in the second column), and the reasons for those changes (in the third column).

The WEDC team then consolidated the data in the matrices and did the mapping against the listed KB catalysts. To illustrate how this would work, we have done a quick mapping of the findings in the table below. We will have a narrative that accompanies the lessons and sets them in context. This will include some theory to anchor the lessons.

Table 16 Example of catalytic factors mapped against KB activities

KB 'catalytic factor'	KB activity (above) ***
Stakeholder involvements: identifying relevant stakeholders	1,3
Stakeholder involvements: trust building	2,3,4
Two-directionality (supply & demand): Element of demand needs articulating	5 (and possibly 6)
Two-directionality (supply & demand) Identifying actionable knowledge'	6

**** The numbers refer to the sections in Table 16*

Doing the above allows us to present the evidence alongside the lessons and should allow readers to reach their own judgement on how to interpret a particular lesson to fit their context.

SUMMARY OF LESSONS LEARNT

Background to lessons learning framework

In work packages 4, 5, and 6, three BESSE research partners in conjunction with BESSE demonstration partners (the water companies) undertook three case studies. The purpose of these case studies was to do knowledge brokerage on specific issues identified by the water companies. The aim of doing the brokerage was to elicit lessons on the brokerage process.

Following completion of the case studies, we decided to present the case studies using a common format to aid comparability, which would then facilitate the drawing of lessons across the three case studies.

Lesson identification

The case study framework developed for lesson learning had three columns. The first relates to the knowledge brokerage activity. The second relates to the significant changes occurring because of the brokerage. In addition, the third column relates to the factors that assisted or hindered the brokerage. We performed an analysis of each knowledge brokerage activity recorded focusing on the resulting changes and factors that assisted or hindered the progress. From these, it was possible to draw generic lessons that would apply for each type of brokerage activity. We assumed that a specific brokering need drove the choice of each brokerage activity. That is, each activity resulted from a rational choice about the best way to proceed with the overarching brokerage goal. Finally, we can characterise the brokerage done within these pilots as intentional. It was intentional because the water companies requested the brokerage. Unintentional brokerage occurs where the recipient of the brokerage does not request it.

The lessons

The lessons identified are not new. Many of these lessons exist already in the literature. The value-added in doing this is to show the applicability of lessons previously identified to environmental sanitation. Many of the lessons learnt are not profound; in fact, some may be almost trite or common sense. This does not mean they hold no value – after all, common sense is not commonly applied. People often need reminding about self-evident things.

Following are the lessons identified from the case studies. The lesson learning frameworks for each case study are included as appendices at the end of this document.

WBL CASE STUDY

Conceptualisation of a sustainable wastewater treatment plant.

We can conclude here that WBL required external facilitation (Maastricht) to progress its sustainability agenda. WBL needed Maastricht to assist it negotiate the complexity of sustainability to gain clarity about what a sustainable sanitation wastewater treatment plant should be for WBL.

This activity led WBL to endorse the principle of building a sustainable plant. WBL was then able to define its criteria for sustainability. The process was assisted by the knowledge that a sister waterboard was already considering similar issues.

Lesson: organisations and people can perceive new ideas and concepts as complex and /or irrelevant. Sometimes they need external facilitation to overcome this barrier.

Lesson: when doing brokerage, one should be aware that resistance could arise from a lack of understanding of the concept (in this case environmental sustainability), especially if the organisation perceives the status quo as working.

Internal dissemination of the BESSE project within WBL.

There was a core group of early adopters within WBL. The group was aware that all or most of WBL needed to be onside for the project to succeed. Identifying key staff within WBL to drive the project represented

a milestone and signalled progress. Disseminating organisation-wide raised awareness, initiating the process of buy-in among staff. WBL staff undertook the dissemination activity. This helped the process (trust among peers), and enabled better communication. Language was barrier

Lesson: brokerage requires wide-acceptance of the innovation. A communication plan is therefore important.

Lesson: one should target all stakeholder groups within the organisation for dissemination

Lesson: where expertise is available in-house, use this expertise to mediate the brokerage

Lesson: As much as possible, broker the innovation in a language the audience speaks fluently

Engagement of the management team.

Maastricht made a presentation to the WBL management team. This included information about BESSE and MARBLE. A facilitating factor was that the student's research goals aligned well with WBL's goals. A difficult identified was lack of clarity about the Maastricht students would offer in concrete terms.

Lesson: high-level engagement is important whatever the context. Management buy-in is crucial.

Lesson: the brokerage should make clear the benefit that will accrue to the organisation in adopting the innovation. The key here is detail. Ideally, you should define the benefit in terms of the organisation's goals and processes.

Lesson: brokers should check that the organisation understands the benefit they will derive from the innovation. Do not assume that your explanation of this suffices. You may need several iterations of explanation before the projected benefit is internalised and becomes clear.

Conversation with Dutch sanitation experts.

The BESSE team held consultations with Dutch sanitation experts to better understand the Dutch context. The result of this conversation was that Maastricht had ready examples in Cannibal, Nerada and Demon to use in their brokerage activity. Further, the knowledge of the involvement of Dutch sanitation experts reassured WBL.

Lesson: It is vital that brokers are familiar with the context within which they will be doing brokerage. This enables them to couch their brokerage in terms that the organisation is familiar with.

Lesson: involve local expertise in the brokerage wherever possible. People respond better to the familiar.

Internal memo.

WBL management issued an internal memo to explain the 'green' concept and what it would mean for WBL. They did this to elicit cooperation and buy-in among staff.

Lesson: Staff need to perceive that management is driving the process. Management can facilitate this by issuing regular updates to keep staff abreast of developments.

Lesson: Related to the above, brokers need to be aware of weak management commitment. Management can say and do all the right things without being fully committed. Staff notices weak commitment quickly.

Meeting between UM-STS, WBL and Marble students.

This meeting provided a platform for stakeholder engagement. At the meeting, a plan of action for the next set of activities was set and WBL suggested a trip to a wastewater treatment plant for the students to learn more about the treatment process. This meeting further facilitated trust building. However, WBL staff were a bit uneasy at the prospect of supervising student projects.

Lesson: seek platforms for engagement. Meetings are a good platform. They need to be frequent at lest initially to facilitate bonding and trust building.

Lesson: Be aware of people's comfort zones. Even highly qualified people will balk at taking on roles they are unfamiliar with

Research conducted by Marble students on their individual research themes.

This research demonstrated clear benefit to WBL in that the students' research aligned with WBL needs.

Lesson: aim to demonstrate tangible benefit early on in the brokerage process. This stimulates further buy-in and commitment to the innovation.

Lesson: one-off initiatives to untangle complex ideas such as sustainability are rarely successful. Plan to have several iterations. If possible, use a different approach and perspective for each session. This helps people get a more rounded picture of the idea than does using a single approach.

Lesson: few innovations become keystone issues for the organisation – that is, become the issue upon which all else in the organisation depends. Therefore, while doing brokerage, it is crucial to bear in mind that your brokerage activity will be competing with other issues for the attention of people in the organisation

Study of the implementation of Cannibal.

BESSE undertook a study of the implementation of the Cannibal, Nereda and Demon projects with the help of the waterboard where Cannibal was implemented, and Siemens – the vendor. This furthered BESSE's understanding of the brokerage process in a similar environment.

Lesson: try to identify where brokerage has worked successfully in a similar environment. If possible, do a study of that brokerage to understand the key success factors.

Lesson: try to identify where brokerage has not worked successfully in a similar environment. If possible, do a study of that brokerage to identify and understand what the key obstacles to brokerage were in that case.

Lesson: involving the brokered to organisation in developing the innovation improves the chances of uptake.

Lesson: brokerage can flounder if the parties to the brokerage are averse to knowledge sharing

Lesson: the consequences of adopting an innovation will differ between organisations. Brokers need to understand the risk threshold of those receiving the brokerage. Sanitation companies have a high risk-threshold because of the public health consequences of sanitation.

Lesson: innovation by itself is not intrinsically good. Brokers need to identify a hook to promote the innovation where its utility is not immediately apparent or only speaks to a niche concern.

Initiation of the BESE pilot project.

This involved discussion between BESSE and the WBL team to further fine-tune the concept of sustainability as it applies to WBL. This led to a broadening of the scope of sustainability within WBL from the desire to build a sustainable modular treatment plant to sustainability becoming more about the 'greening' of WBL

Lesson: sustained engagement improves the chances of both parties (the brokers and the recipients of brokerage) building a working relationship. A strong working relationship in turn further facilitates brokerage.

Green thinking workshop

This workshop was a continuation of the dialogue between WBL and BESSE relating to the idea of greening WBL.

Lesson: it is easier to do brokerage within a small organisation. If doing brokerage in a large organisation, it may pay to target sub-groups within the organisation initially.

Lesson: once the organisation receiving the brokerage accepts the need for innovation, it can quickly move ahead of the brokers in its innovative thinking. Brokers should guard against this.

Workshop report distributed among WBL employees

This was a dissemination exercise designed to further communicate progress on the project and facilitate buy-in by staff.

Lesson: guard against passive audiences. Dissemination gets messages across sometimes but not always. For example, the target audience may not read the report they have received. Brokerage needs to combine a mix of passive and more active communication channels.

Second part of the pilot project

This was to consolidate and agree the scope of green thinking as it relates to WBL. This involved investigating how WBL does sustainability brokerage. This knowledge would then inform development of a WBL strategy map.

Lesson: introduce new ideas to people incrementally. Detail is important but should only come later once people have an overview and understood the high-level implications of the innovation.

Lesson: adopt a brokerage strategy that incorporates elements of co-development. This promotes ownership

Individual interviews conducted with WBL employees

This was to enable the BESSE team to get a good understanding of the project environment. It also enabled the team to get an insight into how sustainability was understood within WBL and identify existing knowledge brokerage mechanisms.

Lesson: It is helpful to obtain as many perspectives on the brokerage issue from staff of the organisation. This should enable understanding of what works within that context.

Lesson: aim to identify the organisation's important stakeholders, particularly those who could influence decision-making within the organisation. Design brokerage mechanisms that take into account this group.

Individual interviews conducted with WBL employees

These presentations provided feedback to WBL on how it is progressing and provided an opportunity for self-assessment.

Lesson: brokerage mechanisms should include monitoring strategies that incorporate reflexive methods for both brokers and the organisation receiving the brokerage.

Lesson: use several brokerage methods and mechanisms to enhance the chance for a quick progress. People respond well to a range of stimuli.

Lesson: be flexible in your approach. Not all brokerage mechanisms will be appropriate. If one approach fails, substitute it with another.

CASTEL S'ANT ANGELO CASE STUDY

Communication

The BESSE project identified lack of communication between the local authority and the scientists working on the sewerage system as a crucial problem. The project worked to establish dialogue between the two, which it achieved. Dialogue served to lower hostility from the local authority. The local authority and the scientists agreed that system monitoring was the most important intervention required. The company SOGEA opposed the BESSE project believing it would undermine its own work. Dispelling this perception improved relations.

Lesson: communication is vital to unlock a deadlock. Brokers should prioritise establishing dialogue where this is lacking. Once dialogue is established, it may reveal that the perceived differences were not as great as thought and pave way for a resolution of the problem.

Lesson: check that all parties understand the reasons for the brokerage. Active communication methods achieve this more effectively than passive methods. Active (face to face) methods allow one to make clarifications and permit the broker to check understanding.

Technical documentation

The BESSE project provided a trigger to collect the available published and unpublished material relating to the sewerage system. This previously distributed material is now available in a central archive improving access to knowledge. This in turn has enabled optimal allocation of financial resources and planning for

maintenance. The project developed a website to act as a focal point for stakeholders including the public to access information.

Lesson: Provide stakeholders with as much relevant information and knowledge relating to the innovation. Full disclosure to everyone involved assists with cohesion building and establishing trust.

Problem structuring

The BESSE project undertook a series of interviews with stakeholders to uncover all the relevant issues that the project would need to address.

Lesson: carry out an audit at the outset to understand all issues concerned. The audit should include all stakeholders and aim to gain an understanding of their perspective on the issue.

PERNIK CASE STUDY

Problem mapping

The project set out to understand the main problems regarding sustainable sanitation in Pernik.

Lesson: communication – addressed above

Lesson: introducing innovation could lead to unintended consequences. An example would be the loss of jobs in the organisation resulting from the innovation. Brokers should anticipate and plan for how to manage such consequences, which could be a powerful source of resistance.

RELATIONSHIP TO THEORY

In work package 2, work was done to identify the hindering and facilitating factors to the transfer and dissemination of knowledge in environmentally sustainable sanitation. This work identified three domains of brokerage – knowledge identification, interaction and application. These domains are defined in the document as:

1. **Knowledge identification domain.** In this domain, knowledge brokerage is aimed at identifying (i.e. selecting and organising), among the available knowledge, those items potentially exploitable in terms of applications and technologies within a given sector (in this case, that of sanitation).
2. **Interaction domain.** In this domain, knowledge brokerage is aimed at creating a relatively stable, meaningful and effective interaction among players who play or should play a role in exploiting new knowledge.
3. **Application domain.** In this domain, knowledge brokerage is strategically aimed at 'implementing' the new knowledge, that is, contributing to transforming it into concrete innovation of any nature (definition of new norms, activation of new research projects, application of new knowledge and technologies, etc.).

Below are the lessons identified above presented according to this categorisation.

Knowledge identification

Lesson: carry out an audit at the outset to understand all issues concerned. The audit should include all stakeholders and aim to gain an understanding of their perspective on the issue.

Lesson: try to identify where brokerage has worked successfully in a similar environment. If possible, do a study of that brokerage to understand the key success factors.

Lesson: try to identify where brokerage has not worked successfully in a similar environment. If possible, do a study of that brokerage to identify and understand what the key obstacles to brokerage were in that case.

Interaction

Lesson: organisations and people can perceive new ideas and concepts as complex and /or irrelevant. Sometimes they need external facilitation to overcome this barrier.

Lesson: when doing brokerage, one should be aware that resistance could arise from a lack of understanding of the concept (in this case environmental sustainability), especially if the organisation perceives the status quo as working.

Lesson: brokerage requires wide-acceptance of the innovation. A communication plan is therefore important.

Lesson: one should target all stakeholder groups within the organisation for dissemination

Lesson: where expertise is available in-house, use this expertise to mediate the brokerage

Lesson: As much as possible, broker the innovation in a language the audience speaks fluently

Lesson: high-level engagement is important whatever the context. Management buy-in is crucial.

Lesson: the brokerage should make clear the benefit that will accrue to the organisation in adopting the innovation. The key here is detail. Ideally, you should define the benefit in terms of the organisation's goals and processes.

Lesson: brokers should check that the organisation understands the benefit they will derive from the innovation. Do not assume that your explanation of this suffices. You may need several iterations of explanation before the projected benefit is internalised and becomes clear.

Lesson: It is vital that brokers are familiar with the context within which they will be doing brokerage. This enables them to couch their brokerage in terms that the organisation is familiar with.

Lesson: involve local expertise in the brokerage wherever possible. People respond better to the familiar.

Lesson: Staff need to perceive that management is driving the process. Management can facilitate this by issuing regular updates to keep staff abreast of developments.

Lesson: Related to the above, brokers need to be aware of weak management commitment. Management can say and do all the right things without being fully committed. Staff notices weak commitment quickly.

Lesson: aim to demonstrate tangible benefit early on in the brokerage process. This stimulates further buy-in and commitment to the innovation.

Lesson: one-off initiatives to untangle complex ideas such as sustainability are rarely successful. Plan to have several iterations. If possible, use a different approach and perspective for each session. This helps people get a more rounded picture of the idea than does using a single approach.

Lesson: involving the brokered to organisation in developing the innovation improves the chances of uptake.

Lesson: brokerage can flounder if the parties to the brokerage are averse to knowledge sharing

Lesson: the consequences of adopting an innovation will differ between organisations. Brokers need to understand the risk threshold of those receiving the brokerage. Sanitation companies have a high risk-threshold because of the public health consequences of sanitation.

Lesson: innovation by itself is not intrinsically good. Brokers need to identify a hook to promote the innovation where its utility is not immediately apparent or only speaks to a niche concern.

Lesson: sustained engagement improves the chances of both parties (the brokers and the recipients of brokerage) building a working relationship. A strong working relationship in turn further facilitates brokerage.

Lesson: it is easier to do brokerage within a small organisation. If doing brokerage in a large organisation, it may pay to target sub-groups within the organisation initially.

Lesson: once the organisation receiving the brokerage accepts the need for innovation, it can quickly move ahead of the brokers in its innovative thinking. Brokers should guard against this.

Lesson: guard against passive audiences. Dissemination gets messages across sometimes but not always. For example, the target audience may not read the report they have received. Brokerage needs to combine a mix of passive and more active communication channels.

Lesson: introduce new ideas to people incrementally. Detail is important but should only come later once people have an overview and understood the high-level implications of the innovation.

Lesson: adopt a brokerage strategy that incorporates elements of co-development. This promotes ownership

Lesson: It is helpful to obtain as many perspectives on the brokerage issue from staff of the organisation. This should enable understanding of what works within that context.

Lesson: aim to identify the organisation's important stakeholders, particularly those who could influence decision-making within the organisation. Design brokerage mechanisms that take into account this group.

Lesson: communication is vital to unlock a deadlock. Brokers should prioritise establishing dialogue where this is lacking. Once dialogue is established, it may reveal that the perceived differences were not as great as thought and pave way for a resolution of the problem.

Lesson: check that all parties understand the reasons for the brokerage. Active communication methods achieve this more effectively than passive methods. Active (face to face) methods allow one to make clarifications and permit the broker to check understanding.

Lesson: Provide stakeholders with as much relevant information and knowledge relating to the innovation. Full disclosure to everyone involved assists with cohesion building and establishing trust.

Lesson: introducing innovation could lead to unintended consequences. An example would be the loss of jobs in the organisation resulting from the innovation. Brokers should anticipate and plan for how to manage such consequences, which could be a powerful source of resistance.

Application

Lesson: few innovations become keystone issues for the organisation – that is, become the issue upon which all else in the organisation depends. Therefore, while doing brokerage, it is crucial to bear in mind that your brokerage activity will be competing with other issues for the attention of people in the organisation

Lesson: brokerage mechanisms should include monitoring strategies that incorporate reflexive methods for both brokers and the organisation receiving the brokerage.

Lesson: use several brokerage methods and mechanisms to enhance the chance for a quick progress. People respond well to a range of stimuli.

Lesson: be flexible in your approach. Not all brokerage mechanisms will be appropriate. If one approach fails, substitute it with another.

VII ANNEX:LIST OF OBSTACLES AND FACILITATING FACTORS

LSC: WP7 based on WP2

This text provides a systematic picture of obstacles and facilitating factors to innovation in sanitation emerged from WP2. It represents the most robust empirical basis of BESSE together with the pilot projects. It could be useful both for further developing the picture of the situation of innovation in sanitation (already depicted in the text 'Knowledge brokerage and innovation in environmental sustainable sanitation') and as an annex to the final report..

List of Obstacles and Facilitating Factors

This annex contains a complete list of obstacles and facilitating factors, organised according to the four resistances to innovation.

Table 17 ANNEX: Technological Inertia

No.	Obstacle	Description
O01	Large infrastructures characterising the sanitation sector	The sanitation sector is characterised by high-capitalisation companies and large-scale infrastructure, so that innovation requires huge investments. Most companies are nowhere near coming to the end of their asset lifespan and the only technologies that they would seriously consider are those that tweak existing plants, usually by adding on a bit of kit. This limits the opportunities for adopting sustainable technologies that represent a step-change. (Source: BESSE in-depth interviews)
O02	Limited acknowledgement by the utilities of the economic value of knowledge	This often drives utilities not to devote due attention to the evidence given in support to alternative knowledge and technologies. (Source: CHSRF, 2003; Breton, Landry, Ouimet, 2002)
O03	Presence of strong lock-ins	The sanitation sector is affected by many lock-ins, that is, consolidated technological standards which are difficult to overcome because of costs, high investments in training or cultural reasons. They mostly derive from the fact that the technological system of sanitation has been the same for decades. (Source: Glor, 2007; Bianchini, 2002; Davenport,
O04	Risk-adverse attitude of water utilities	Utilities (both public and private) are reluctant to take the risks involved in developing innovations. Investments are only made in technologies that are nearly proven and very little is done on really new (and more risky) technological solutions. (Source: BESSE in-depth interviews)
O05	Conservative interpretation of the mission of water utilities' professionals	In water utilities, many professionals share a vision of their professional mission based on the imperative 'supply water and eliminate wastewater '. This approach, paradoxically, makes them reluctant to innovate and sceptical of multidisciplinary approaches. In fact, operators see new technological solutions as unreliable and not credible, their fear being that users would be seriously harmed. (Source: BESSE in -depth interviews)

O06	Underestimation of the social and organisational implications of innovation	Utilities tend to have a vision of innovation which emphasises technological aspects and underestimates social and organisational implications, e.g. training activities, long-term maintenance procedures, possible users' lifestyle changes or citizens' acceptance of the new technologies. (Source: Ecosan Services Foundation, 2004)
O07	Inadequate attention towards Operation & Maintenance	Utilities and local authorities seem to underestimate the relevance of innovation for improving Operation & Maintenance. This can be a distorting factor in choosing between alternative investments in new knowledge and technology and in long-term innovation. (Source: Alanne, Saari, 2004; Ecosan Services Foundation, 2004; Eales, 2008; Palaniappan, Lang, Gleick, 2008; Whitworth, Whitworth, 2005; Ramalingam, 2005)
O08	Adoption of technological choices separated from overall strategic orientations	In water utilities there is the tendency to outsource technology and knowledge transfer processes, without an early involvement of utility managers. In this way, technological decisions tend to be separated from overall strategic orientations. (Source: Palaniappan, Lang, Gleick, 2008; Ealez, 2008; Whitworth, Whitworth, 2005; Sondergard, Hansen, Holm, Kerndup, 2004; Ramalingam, 2005)
O09	Resiliency of work routines in water utilities	Beyond strictly technological lock-ins, utilities are strongly oriented to keeping their own set of routines, even when they are no longer effective. (Source: Glor, 2006; CHSRF, 2003)
O10	Top-down approach adopted by sanitation utilities in technological and organisational change	This tendency (also based on the will to simplify and speed up procedures or to avoid controversies) often leads to conflicts and tensions, both within the utility and between the utility and other stakeholders; this risks slowing down or blocking the innovation process. (Source: Murphy, McBean, Farahbakhsh, 2009; Eales, 2004)
O11	Rigid separation between organisational units within the utilities	Extreme organisational and sectoral segmentation fosters diverging visions on priority investments and how to plan and manage technology and knowledge transfers. This is obviously truer when sanitation services are delivered by different bodies or companies. (Source: Bixio et al., 2006; Water Supply and Sanitation Technology Platform, 2005; Akagawa et al., 2006; Seppala, 2008; Spaargaren , 2005; Cozzens, Catalán, 2007)
O12	Bureaucratisation of innovation procedures and processes within utilities	Bureaucratic and fund-raising procedures within the utilities slow down the innovation process even more, which is already very time-consuming. (Source: Besse in-depth interviews)
O13	Limited dissemination of knowledge management procedures and tools among utilities	Lack of knowledge management skills hinders properly driven knowledge-related processes (knowledge acquisition, production, adaptation, transfer, etc.) within the utility. For the same reasons, those who have useful knowledge are not in the condition to exploit it. (Source: Palaniappan, Lang, Gleick, 2008; Eales, 2008; Whitworth, Whitworth, 2005; Sondergard, Hansen, Holm, Kerndup, 2004; Ramalingam, 2005)
O14	Waste of viable knowledge in water utilities	There is a poor awareness of utility managers regarding the already available knowledge within their own organisations. This phenomenon has, among its effects, a waste of the available knowledge and unnecessary extra-costs to look for new knowledge elsewhere. (Source: Dobbins et al., 2009; Breton, Landry, Ouimet, 2002)

O15	Poor adaptation of new knowledge and technology to local conditions	Technology providers and knowledge producers are often inclined to underrate (and sometimes to hide) problems and extra-costs deriving from adapting new knowledge and technologies to the specific local context. (Source: Ecosan Services Foundation, 2004; Palaniappan, Lang, Gleick, 2009)
O16	Overestimation of the utilities' absorption capacities of new knowledge and technologies	This is particularly true for small-sized sanitation service providers, which usually show limited technological and management skills. When the innovation to be absorbed is too great, the organisation may get into serious difficulty. (Source: Ecosan Services Foundation, 2004; Fittschen, Niemczynowicz, 2007)
O17	Tendency to transfer technologies devoid of relevant information on their use and applications	We are referring to information pertaining to aspects such as maintenance-related organisational requirements, long-term sustainability, impacts on different population groups, relationships with other technological packages or requirements for scaling up their application. (Source: Bixio et al., 2006; Eales, 2004; Murphy, McBean, Farahbakhsh, 2009; Rautanen, Viskari, 2006)
O18	Poor quality in planning knowledge and technology transfer	The literature shows that technology providers, even when well prepared and advanced in their technological field, are less able to properly plan and implement all the aspects related to the technology transfer process (e.g., drafting the technical manuals, personnel training, coordination of the different transfer phases, legal and contractual aspects, communication with users, etc.). This dimension is often underestimated and undertreated in priority setting and in selecting new technological solutions. (Source: Kingdon, 1995)
O19	Sort-term vision of utilities	Utilities have to constantly respond to emergency situations and resolve specific problems in the everyday running of plants. Thus, they prefer to seek immediate solutions rather than experiment longer-term innovative policies. (Source: BESSE in-depth interviews)
O20	Lack of continuity in communication among sanitation players	Communicating consumes time and resources. Therefore, players tend to mainly communicate when they are involved in specific programmes or when they are looking for new funds. Routinely, communication among different kinds of players is poor and inadequate with respect to the real needs. (Source: CDRI, 2006)
O21	Lack of transparency in the decision-making process within the utilities	This phenomenon – still characterising many utilities and local authorities all over Europe – is a serious factor hampering an effective communication among sanitation players. (Source: Castro, 2007; Ghosh, Pennings, 2009)

Table 18 ANNEX: Collective Disengagement

No.	Obstacle	Description
O22	Low awareness of the existence of liquid waste	The public perception of the existence of liquid waste is slight. Waste is commonly thought to be just solid, even though a person daily produces a hundred times more liquid than solid waste. It also escapes notice that solid and liquid waste are linked (once treated, one produces the other). (Source: BESSE in-depth interviews, NL)
O23	Very low public visibility of the sanitation sector	While public opinion is sensitive to water issues, it is much less so to wastewater disposal. There is little awareness of the very existence of this sector and its problems. Sanitation is not 'visible ', so that local authorities do not invest in this sector, since it does not provide significant economic and electoral returns. (Source: BESSE in-depth interviews, NL)
O24	Health fears raised by wastewater reuse	Widespread health fears were recorded on the reuse of waste water. These are due to a representation of hygiene as disinfection and total freedom from germs and bacteria. These fears and resistance are anchored to the conventional model of sanitation, hampering any effort at innovation. (Source: BESSE in-depth interviews, NL)
O25	Lack of opportunities to spur public communication on sanitation	Scarce public communication on sanitation was found, owing to a lack of institutionally recognised occasions where sanitation-related issues could be publicly discussed, such as public meetings and conferences or programmes of social dialogue. This trend is found all over Europe, albeit to different degrees. (Source: NHT, 2006; Bijker, d'Andrea, 2009)
O26	Poor perception of the close relations between sanitation, health and environment by citizens and many sanitation players	Many citizens are not aware of the relationships between sanitation, health and the environment, and tend to underrate them. For various reasons (e.g., professional specialisation), many technicians and researchers often underrate them too. (Source: Ecosan Services Foundation, 2004; Fittschen, Niemczynowicz, 2007; Bixio et al., 2006)
O27	Low awareness of the problem raised by conventional sanitation	People are generally unaware that traditional sanitation is a type of solution that produces serious problems, since it uses a lot of water and wastes nutrients. These aspects are only now beginning to be appreciated. They involve global changes that are unknown at the social level but familiar to the scientific community, such as changes to the nitrogen and phosphorous cycles. (Source: BESSE in-depth interviews)
O28	Limited orientation of citizens and civil society organisations to get involved in technological innovation	This overall trend was recorded by many European opinion polls showing that scientific and technological research is scarcely perceived as a priority by the public at large. (Source: Bixio et al., 2006; Water Supply and Sanitation Technology Platform, 2005; Akagawa et al., 2006; Seppala, 2008; Spaargaren, 2005; Bijker, d'Andrea, 2009)

O29	Distrust of science and technology	An increasing distrust of science and technology has been recorded in the last two decades in many layers of society, affecting science-society relations as a whole. In the sanitation sector, it entails the distrust of the reliability of new technological solutions, even if inspired to principles of sustainability. (Source: Ziman, 2000;Bijker, d'Andrea, 2009)
O30	Opposition of health professionals to decentralised sustainable sanitation solutions	Health experts oppose sustainable sanitation because their views on this issue are conventional. The health sector, in fact, is in some way opposed to sustainable sanitation solutions. This attitude is due both to a lack of trained health technicians and to an attitude of excessive caution that characterises health operators. (Source: BESSE in-depth interviews)
O31	Farmers' opposition to the reuse of waste water	In some countries, farmers are very much against reusing waste water, partly because of a general conservative attitude, and partly because quality certification systems commit them to using spring water. (Source: BESSE in-depth interviews)
O32	Opposition of traditional engineering culture to sanitation decentralisation	The traditional professional culture of engineers favours a model of sanitation based on increasingly large and interconnected plants, while sustainable sanitation involves localised solutions. Not by chance, in hydraulic engineering departments and urban planning faculties, the dominant message is that small plants do not work. In this regard, the development of sustainable sanitation means revolutionising the way the urban network is conceived. (Source: BESSE in-depth interviews)
O33	Distrust towards the private sector by decision-makers, public utilities, public research institutions and civil society organisations	This trend, which appears to be widespread in Europe, is based on the fear that private firms could unduly interfere in research projects and outputs by influencing technological decisions in order to increase their profits or hide the environmental risks regarding the technological solutions they are proposing. (Source: Kumudini Abeysuriya et al., 2007; CHSRF, 2003)
O34	Widespread stereotypes regarding various sanitation players	Professionals and policymakers often see researchers as scarcely focused on practical goals; researchers, in turn, tend to see sanitation utilities' professionals as too oriented to practical issues and not interested in knowledge; decision-makers are often viewed as interested only in the political impacts of innovation (and therefore on solutions ensuring visibility, such as new plants or new buildings). (Source: Cozzens, Catalán, 2007)

No.	Facilitating factor	Description
F06	Increasing social mobilisation on environmental protection	This mobilisation, which can come about in both conflictive and cooperative forms, is succeeding in putting sustainable development on national and international political agendas. An increased significance of sustainable development in public debate can strengthen the propensity of local and national authorities and utilities to review their own priorities, technologies and methods on a fairly regular basis. (Source: Water Supply and Sanitation Technology Platform, 2005)
F07	Increased capacity of civil society organisations to produce and assess technical and scientific knowledge on sanitation	This factor has various impacts, such as the spreading of environmental protection monitoring and evaluation systems fully managed by citizens' organisations, or civil organisations' increasing control over the reliability of technical and scientific data provided by utilities and research institutions. (Source: Ecosan Services Foundation, 2004)
F08	Weakening of the distinction between experts and non-experts	This is not only due to the decreasing 'charisma ' of science, but also to the great spreading of scientific and technical skills among non-experts, the so-called 'lay people '. This trend is evident in the environmental sector. It often generates controversies and conflicts, but it also allows faster and easier communication on the effectiveness and usefulness of new technologies and knowledge. (Source: SNHF, 2008)
F09	Reinforcement of two-way communication between utilities and users and between local authorities and citizens	This well-established trend is found in many sectors, mainly in the enhanced use of web-based communication, the improvement of public relations offices and the application (sometimes established by law) of procedures aimed at ensuring transparency and rapid interaction with citizens. All this makes it easier to understand users' needs and expectations since the 'feedback loop ' is faster, cheaper and easier to implement. (Source: Ecosan Services Foundation, 2004)
F10	Acknowledgment of civil society players as fully legitimate to be involved in decision-making process	Even this trend is well-established, dating back to the 1970s, even though it has been put into practice in different ways of variable effectiveness. In any case, it is a fact in Europe that the legitimacy of civic organisations to take part in decision-making processes having important impacts on community life is no longer questioned at all. (Source: Eales, 2004)
F11	The spreading and strengthening of participatory methods in public decision-making processes	This refers to such things as participatory forecasting, approaches to 'deliberative democracy ', public juries or public hearings, and participatory action-research. However, these approaches have rarely been usefully applied in the sanitation sector. (Source: Fittschen, Niemczynowicz, 2007; Spaargaren, 2005; CHSRF, 2003; Ecosan Services Foundation, 2004)
F12	Stakeholders' tendency to have a proactive role in innovation	Local communities and civil society organisations are more proactive and skilled in producing evidence on different technological options. This trend is widespread in many sectors (e.g., energy, consumer protection, etc.), including environmental services. (Source: Bixio et al., 2006; Water Supply and Sanitation Technology Platform, 2005; Akagawa et al., 2006; Seppala, 2008; Spaargaren, 2005)

Table 19 ANNEX: Immobility of the Institutional Actors

No.	Obstacle	Description
O35	Low political priority assigned to investments in sanitation	A factor hindering the innovation process is the low political priority assigned to investments in sanitation. Most government funds for sustainability are allocated to other spheres (i.e., renewable energy). (Source: BESSE in-depth interviews)
O36	Instability of the political directions in the sector	This is due to various factors (local or national elections, changes in utilities' management, media campaigns, political controversies, etc.) and can produce various effects (such as a stop to ongoing programmes, sudden changes in the allocation of resources, personnel redistribution, etc.) which, in turn, may hinder the development of stable communication networks. (Source: Glor, 2006; CHSRF, 2003)
O37	Low awareness of the social dimension of sanitation	Many observers noted a prevailing technical approach to innovation, thereby underrating the social dimension of sanitation. In this way, social knowledge stocks (for example, on consumer orientations and expectations or on people's role in sanitation governance), which may be pivotal for sanitation governance, remain unused. (Source: Castro, 1995, 2006)
O38	Poor awareness of utilities and local authorities regarding their own technological and knowledge needs	This is mainly due to the fact that sanitation utilities and local authorities are mainly focused on daily service provision, administration-related issues, service rates and costs, while they devote discontinuous and, sometimes, wavering attention to new technologies and knowledge to be acquired. (Source: Alanne, Saari, 2004; Ecosan Services Foundation, 2004; Eales, 2008; Palaniappan, Lang, Gleick, 2008; Whitworth, Whitworth, 2005; Ramalingam, 2005)
O39	Poor technical skills in environmental technologies among the key actors of sanitation governance	Decision-makers and public administration representatives often have no specific expertise in the environmental field, with specific reference to sanitation. Even resorting to experts specialised in sanitation issues, in order to develop sanitation policies, is relatively rare. (Source: BESSE in depth interviews)
O40	Lack of skills in managing information and knowledge on sanitation-related issues available on the Internet.	As in other sectors, Internet development has made a great deal of information and knowledge on sanitation-related issues available. Governance players are often unable to select the relevant, appropriate and reliable information and knowledge they actually need for developing sound sanitation policies and measures. (Source: Nicolaon G., 2007; Carnabucci G., Bruggeman J., 2008)
O41	Decision-makers' limited knowledge of the most advanced research strands on sanitation	One of the main obstacles to knowledge transfer is that decision-makers are usually unaware of the problems of pioneering research in the sanitation field. Decision-makers often fail to perceive either technological novelties or new emerging needs relating to sanitation systems. The result is that even public funding schemes do not always manage to stimulate innovation because they are not sufficiently updated to identify new perspectives and technological options. (Source: BESSE in depth interviews)

O42	Lack of a systemic approach to sustainable sanitation policies	Much current work on sanitation is looking at partial solutions. What is lacking is a total concept of how to make sanitation more sustainable and an idea of what is needed for the transition of the system as a whole. (Source: Besse in depth interviews)
O43	Inadequate time and procedures in funding research	Especially in some countries, it is difficult to get state funding for research because of the lengthy procedures and time required. This is an overall obstacle to research, but it has harder impacts on under-funded sectors, as sanitation is in many countries. (Source: BESSE in depth interviews)
O44	Unstable normative framework	In various countries, the continuous production of new norms combined with frequent changes in existing ones make the legal framework regulating the adoption of new technologies particularly unstable. This fact discourages public administrations and companies to invest in innovative technologies. (Source: BESSE in depth interviews)
O45	Normative framework lagging behind advancements in science and technology	Innovation can be hindered by current regulations that constantly lag behind new orientations in scientific research and the possibilities offered by new technologies. For example, even newly built treatment plans are based on old concepts that do not incorporate sustainability and reuse criteria. (Source: BESSE in depth interviews)
O46	Poor clarity of sanitation norms	At least in some national contexts, sanitation norms are considered not very clear and open to various interpretations. Moreover, policymakers' scant knowledge of existing norms (especially those regulating the adoption of new technologies) was also recorded. This makes decision-makers more insecure about which new technologies actually match the standard and parameters established by existing norms. (Source: BESSE in depth interviews)
O47	Weak support to competitiveness in the sanitation technology market	Public utilities operate in regulated markets, where profit is generally independent of a company's capacity to introduce innovative products. In a regulated market, consumption is predictable and constant, regardless of the type of innovation developed. In this framework, when specific incentives are not in place and goods and services are not subject to direct competition, the drive to innovate is rather weak. (Source: BESSE in depth interviews)
O48	Lack of incentives to sustainable sanitation	Especially in some national contexts, there is a lack of incentives to get utilities to adopt sustainable solutions in the sanitation field. For example, while mechanisms exist to discount costs by 50% for interventions concerning energy, there is nothing similar for interventions in water and sanitation. (Source: BESSE in depth interviews)

No.	Facilitating factor	Description
F13	Increasing tendency of research funding agencies to fund projects relating to public policies	This tendency is getting stronger and is urging research institutions to be more sensitive to the research demands emerging from society. This is occurring also in the sanitation sector. (Source: CNHF, 2008)
F14	Increasing investment in research relating to sustainable development	This process has been getting stronger in recent years and is expected to speed up in the future. Investments are an incentive for researchers and research institutions to introduce knowledge scouting procedures and to select research projects and strands which are more likely to be funded. This process involves the sanitation sector, too. (Source: Alanne, Saari, 2004; Ecosan Services Foundation, 2004; Eales, 2008; Palaniappan, Lang, Gleick, 2008; Whitworth, Whitworth, 2005; Ramalingam, 2005)
F15	Increasing investment in environmental sectors within a green-economy perspective	This trend – which is occurring at a different pace in the various countries – should be considered as an opportunity for utilities to innovate, allowing them to access public and private investment and to more easily contact companies bearing specialised knowledge and technologies. This can help utilities to change their technologies and routines and to review their priorities. (Source: Alanne, Saari, 2004; Ecosan Services Foundation, 2004; Eales, 2008; Palaniappan, Lang, Gleick, 2008; Whitworth, Whitworth, 2005; Ramalingam, 2005)
F16	Adoption of the expected impact as one of the criteria to be used in evaluating research quality	In the so-called 'post-academic science ', research evaluation methods are increasingly using social, economic or technological expected impacts as one of the most significant criteria. The scientific community is thus more motivated to 'contextualise ' research projects according to the specific research demands expressed by the different societal and economic sectors. (Source: Georghiu and Keenan, 2006; Nowotny et al. 2001)
F17	Growing orientation fostered by governments towards 'problem -driven ' and strategic research	This tendency is part of the broader orientation of political leaderships to drive research for fostering national economic development. This is supporting the spreading of procedures aimed at screening scientific knowledge open to exploitation. (Source: Alanne, Saari, 2004; Ecosan Services Foundation, 2004; Eales, 2008)
F18	Increased use of 'expert knowledge ' in decision making and public policy design	Experts bearing specific technical and scientific knowledge are increasingly employed as technical supports in decision-making and policymaking. This should facilitate the 'transduction ' of demands relating to service management into research demands. This trend is found in all sectors, including sanitation. (Source: Holm, Sondegard, Hansen, 2004; Bixio et al., 2006; Ecosan Services Foundation, 2004; Eales K., 2008)

Table 20 ANNEX: Research Weakness

No.	Obstacle	Description
O49	Poor engagement of research players on issues relating to sanitation governance	Researchers and research institutions usually show limited interest in, and poor capacities for, orienting their own research activities towards the demands expressed by players involved in sanitation governance. (Source: Clark and Kelly, 2005)
O50	Lack of cooperation between researchers and sanitation stakeholders in research design exercise	Universities suffer a lack of mechanisms and intermediate institutions allowing stable cooperation between researchers and stakeholders, mainly in the research design process. This is particularly serious in the sanitation field, where strong cooperation would help research to be much more in tune with the expectations and needs of stakeholders, especially utilities and local authorities. (Source: BESSE in-depth interviews)
O51	Persistence of strong disciplinary barriers	In a sector like sanitation, which is interdisciplinary by nature, this phenomenon makes it more difficult to create bridges across different knowledge stocks to make them fully usable. (Source: Knorr Cetina, 1999; Castro, 1995, 2006)
O52	Hyper-specialised approach adopted by researchers and technology developers	This often prevents the development of an overall picture of the key problems to deal with as well as an extreme fragmentation of knowledge and technologies, making brokerage-oriented activities more difficult to carry out. (Source: Clark, Kelly, 2005, Verschuren, 2009)
O53	Poor connections of universities and research institutions on sanitation with global trends in research	This makes it difficult to combine knowledge travelling on the global networks with locally-produced knowledge. (Source: NHT, 2006; Water Supply and Sanitation Technology Platform, 2005; IWA, 2008)
O54	Low orientation of universities and research institutions towards the economic and social application of scientific knowledge	The post-academic approach characterised by special attention to the economic and social application of scientific knowledge, although getting stronger almost everywhere, still meets serious obstacles within research institutions and universities. This fact still makes it difficult to screen knowledge usable for sanitation governance. (Source: NHT, 2006; Bijker, d'Andrea, 2009; Verschuren, 2009)
	ation tools	time-based procedures. Often, the lack of an innovation-oriented evaluation approach makes it more difficult to select new knowledge actually usable in managing sanitation. (Source: Uusikylä, Virtanen, 2008)
O56	Poor use of the results of research evaluation exercises	This tendency reduces the possibility to apply new knowledge coming from research that has been evaluated to match new demands coming from governance players, to devise new sanitation policies and to connect innovation and research. (Source: Uusikylä, Virtanen, 2008)
O57	Tendency of research and professional networks to become self-referential	Many research or professional networks, mainly when they are informal, cohesive and based on strong trust-based relationships, often tend not to keep themselves open to external inputs and show a decreasing propensity to exchange information with researchers or players belonging to other networks. (Source: Ahuja, 2001; Burt, 2005)

O58	Limited communication channels between different stakeholders	Researchers, sanitation utility managers and experts in social issues – all playing an important role in the sanitation innovation policies – bear different 'epistemic cultures ' which drive them to attach importance to different aspects and to handle knowledge and information following diverging approaches. Therefore, establishing mutual links in this framework appears particularly difficult. (Source: Knorr Cetina, 1999; Castro, 1995, 2006)
O59	Fragmentation of information sources (journals, websites, databases, inventories) on scientific and technological research on sanitation	Information and knowledge, although more accessible than it was in the past thanks to ICT, is still scattered and difficult to be singled out. This can hamper the selection of potentially useful knowledge and technologies by utilities, decision-makers and stakeholders. (Source: FWR, no date; IDRC, 2008; NHT, 2006; Castro, 2006)
O60	Hindrances in identifying the right contact persons within organisations to communicate with	Apparently, this is a minor problem. However, it becomes particularly significant in the context of knowledge transfer processes, which require high-level coordination among multiple organisations and, within them, among multiple organisational units. (Source: BESSE in-depth interviews; Bijker, d'Andrea, 2009)
O61	Limited scientific skills within utilities and local authorities	According to some of the consulted sources, there is a lack of knowledge in local authorities and utilities on issues relating to sustainable sanitation. There are very few people who can actually evaluate new technologies or the design of a treatment installation. (BESSE in-depth interviews)

No.	Facilitating factor	Description
F19	Consolidation of trans-disciplinary research areas	This trend started with the growing importance of research fields at the crossroads of different disciplines (such as ICT or biotechnology). This trend is now spreading and is likely to weaken disciplinary barriers also in the sanitation sector. (Source: Huber, 1996; IDRC, 2008)
F20	Spreading of inter-disciplinary university curricula on environmental management	Although widespread within national contexts to varying degrees, this tendency is expected to become stronger in the near future, allowing an easier exchange between different stocks of knowledge pertaining to sanitation. (Source: Hellstrom, 2001)
F21	Spreading of trans-disciplinary publications and scientific networks on sanitation	This contributes to making knowledge exchange easier among players and/or researchers of different disciplinary and professional specialisation. (Source: Nowotny et al., 2001; Ziman, 2000)
F22	Spreading of intermediate structures between research and industry	Intermediate structures such as high-tech incubators, science and technology parks, and university industrial liaison offices are currently spreading. This tendency is related to the so-called 'university third mission ', the development of which is urging research institutions to establish knowledge scouting inner procedures. This has important impacts also in the sanitation sector. (Source: IDRC, 2008)
F23	Promotion of research teams involving both researchers and utilities	This trend – promoted by both European and national research funding bodies – is strengthening the habit of research institutions, utilities and other stakeholders to cooperate. Establishing such integrated teams is often a necessary requirement to access funds. (Source: IDRC, 2008)

F24	Tendency of research groups to be in the market and cooperate with the utilities' technical units	This tendency can be understood as an effect of an increasingly competitive access to research funds, urging research institutions to proactively look for fresh funds and new funding sources. Researchers are progressively learning to manage market dynamics and to demonstrate the validity of the alternative technological options. (Ramalingam, 2005)
F25	Spreading of university-industry partnerships	Universities are increasingly promoting and implementing research programmes on sanitation with the direct cooperation of private companies. These partnerships are often based on framework agreements establishing tasks, rights and responsibilities of each partner. (BESSE in-depth interviews, BG, IT, NL, UK)
F26	Spreading of databases on technological options and mapping exercises of research programmes	Databases and mapping exercises are proposed by various players (such as universities, research funding agencies, private firms, etc.). Many of them start being accessible on the Internet. Although being of variable quality, they are important tools facilitating knowledge scouting. (Source: IDRC, 2008)
F27	Emergence of a new post-academic generation of researchers more skilled to communicate and exchange with other players.	This tendency, recorded by the literature, seems to be stronger in the research fields where research is closely intertwined with social issues (such as medical research or environmental research). (Source: Hellstrom, 2001)
F28	Spreading of 'demonstrating projects '.	This practice is particularly widespread in the environmental sectors, through the promotion and implementation of pilot projects (sustainable model districts, ecologically sustainable buildings, highly innovative plants, etc.) to be taken as reference experiences aimed at making innovation 'visible ' and showing the validity and feasibility of new technological options. (Source: Alanne, Saari, 2004; Ecosan Services Foundation, 2004; Eales, 2008; Palaniappan, Lang, Gleick, 2008; Whitworth, Whitworth, 2005; Ramalingam, 2005)
F29	Informal ties between utilities and research organisations	A very widespread practice is that of the development of informal ties between utilities' leaders and individual researchers or research groups. This allows utilities to directly talk to research groups and to keep track of new developments at universities through informal contacts. (Source: BESSE in depth interviews)

ANNEX: MAIN KB PRACTICES USED IN SANITATION

LSC: WP7 based on WP2

This text provides a framework of the main practices connected to KB used in sanitation, as they emerged from WP2. It could be useful for enriching the guidelines with examples and cases. It may also be included as an annex to the entire final report.

This annex contains a complete list of practices of knowledge brokerage, organised according to the four resistances to innovation.

This annex contains a complete list of practices of knowledge brokerage, organised according to the four resistances to innovation.

Table 21 ANNEX: Technological Inertia

No.	Practice	Description
P01	**In-house scouting**	Different water utilities carry out in-house scouting of the company's operational needs in terms of management, new activities to be carried out or new investment. (Source: BESSE in-depth interviews, IT, UK)
P02	**Internal networking activities**	In a big company that produces new technologies, the practice of carrying out an intensive internal networking activity has been recorded. One of the instruments used is an internal newsletter that provides information on what the company is doing. (Source: BESSE in-depth interviews, IT)
P03	**Activation of a network involving technology designers and users**	A company that produces new technologies promoted a network involving technology designers (such as surveyors, engineers, architects, etc.) and all the players involved with the use and control of the technologies provided by the company, such as assessment bodies, provincial and municipal authorities and the companies responsible for controlling treatment plants. (Source: BESSE in-depth interviews, BG, IT, UK)
P04	**Participation in networks**	Another practice recorded is the active participation of utilities in trade associations and organisations, which provides them with the opportunity to discuss and exchange innovative experiences. (Source: BESSE in-depth interviews, IT, UK, NL)
P05	**Involvement of users in maintenance**	A strategy to promote innovative natural treatment methods that was recorded in the study is to involve end-users (usually businesses) in plant maintenance. This is because natural treatment systems require a high level of maintenance. To this end, user-friendly systems have been developed making it easier to monitor activities and allowing operators to carry out repairs directly, without asking for external technical assistance. The technology supplier also provides training for the technical staff of plant operators and provides a set of maintenance manuals. (Source: BESSE in-depth interviews, IT)
P06	**Making water treatment plant and water reuse visible**	In a project studied in the study, water treatment plants and water reuse were made visible and 'socialised ' (not hidden), connecting treatment tanks to the fountains of a public park. The aim was to make citizens aware of the importance and effects of water treatment and sanitation. (Source: BESSE in-depth interviews, IT)
P07	**Public communication on innovations by SMEs**	A consultancy company on water issues drew attention to what SMEs were carrying on in the field of innovation by launching a specific public communication initiative. With this action, many small-scale initiatives in the Netherlands came to light. (Source: BESSE in-depth interviews, NL)

P08	**Fairs and exhibitions on technologies**	Sanitation technology suppliers, on the example of other sectors, such as pharmaceuticals, organise fairs devoted to the exhibition of water technologies. (Source: BESSE in-depth interviews, IT, UK)
P09	**Tours of plants**	A water utility, contacted within the study, regularly organises visits to sanitation plants for its personnel, where interesting experiments have been carried out using new technologies. (Source: BESSE in-depth interviews, BG, IT, NL, UK)
P10	**Establishment of demo-sites**	Some water utilities and public administrations have established demo-sites where technology suppliers can try out a new technology. It is a practice that allows carrying out practical experiments of innovative technologies in the sanitation field. (Source: BESSE in-depth interviews, NL)
P11	**Spin-off companies**	Another practice of technology transfer that is being pursued in some research centres is the establishment of spin-off companies. (Source: BESSE in-depth interviews, NL)
P12	**Ph.D. recruitment**	There are many links between universities and companies so that many Ph.D. students are hired by companies that collaborate with universities even before they finish their degree. This close collaboration makes it possible for innovation to come about relatively fast. (Source: BESSE in-depth interviews, NL)
P13	**Competitions for promoting innovation**	In selecting innovations to be adopted, water utilities in some countries organise competitions mostly involving private companies that have collaborated with research institutions to develop new technologies. Innovation, therefore, is not direct but usually purchased from the outside. (Source: BESSE in-depth interviews, NL)
P14	**Partnerships with non-competing companies**	One practice recorded is to create partnerships with a good mix of companies. The aim is to bring companies together that are not competitors, which leads to increased interaction between companies. (Source: BESSE in-depth interviews, NL)
P15	**Decentralised sewage systems**	Decentralised sewage systems and treatment schemes are being experimented which prove to be well performing and conducive to innovation. They involve the interaction of various public and private players and an analysis of the needs and characteristics of the territory. (Source: BESSE in-depth interviews, IT, NL)

Table 22 ANNEX: Collective Disengagement

No.	Practice	Description
P16	**Using local cooperatives in managing sanitation services**	The fragmentation of plant management promoted by sustainable sanitation is easier if the community is involved in the process of building and managing the plants. This strategy was implemented in Rome (Italy), where a local cooperative manages the constructed wetland and provides for its maintenance. (Source: BESSE in-depth interviews, IT)
P17	**Adoption of monitoring procedures for utilities' operations**	In some countries, utilities – even those having a monopoly – undergo strict monitoring procedures, also conducted by local administrations, particularly as regards costs. The aim is to guarantee their transparency and efficiency. This creates further demand for new efficient technologies. (Source: BESSE in-depth interviews, NL)
P18	**Demonstration projects addressing decision-makers**	Over the past 15 years, with the spread of pilot projects, scepticism of natural water treatment (constructed wetlands) has fallen significantly. A company that produces innovative wetland equipment organises tours of these plants for decision-makers. (Source: BESSE in-depth interviews, IT)
P19	**Experimental projects as showcases**	In one of the experiences observed by the study, a new sustainable wetland plant was observed. Tours of the plant were often organised to show visitors how it works. This has helped spread the idea of using constructed wetlands among citizens and civic associations. (Source: BESSE in-depth interviews, IT)
P20	**Outreach activities**	Various initiatives envisaged outreach experiences (pavilions, expositions, etc.) connected to a sustainable plant, in order to raise awareness on the relationship between the environment and sanitation. (Source: BESSE in-depth interviews, BG, IT, NL, UK)
P21	**Promotion of a free newspaper on innovative sanitation policy**	In order to improve the involvement of civil society in sanitation, a utility issues and distributes a free newspaper to inform citizens about its investment programmes. (Source: BESSE in-depth interviews, BG)
P22	**Training projects on sustainable sanitation issues**	An association of citizens engaged with water issues promoted educational projects in schools of agriculture on the separation of urine. (Source: BESSE in-depth interviews, IT)
P23	**Environmental education on water and sanitation**	Various water utilities, whose activities were recorded during the study, carry out environmental education projects in schools and take part in awareness-raising campaigns on environmental issues concerning water and sanitation. (Source: BESSE in-depth interviews, BG, IT, NL)
P24	**Awareness-raising activities among students to cope with the shortage of personnel in technology companies**	To cope with the shortage of personnel in technological companies specialised in sanitation, a Dutch research centre promotes awareness-raising activities on water and sanitation to get students to take courses in areas where people are actually needed. The programme runs from primary school through high school, showing experiments with water and explaining what water technologists do. The research centre has also built 200 demonstration sets for projects in high schools. (Source: BESSE in-depth interviews, NL)

P25	**Informal constructed wetlands network**	To promote the development of wetlands, an informal network of constructed wetland stakeholders has been promoted in Italy. It is also thanks to the work of this network that wetlands are becoming more common in the country. (Source: BESSE in-depth interviews, IT)
P26	**International network on sustainable sanitation**	To promote sustainable sanitation, a first global sustainable sanitation network, SuSanA, has been promoted. SuSanA works as a coordination platform, sounding board, contributor to the policy dialogue on sustainable sanitation and a 'catalyst '. (Source: BESSE in-depth interviews, IT, NL, UK)
P27	**Projects to promote meetings among stakeholders**	An Italian research institute promoted a programme of meetings to raise awareness, provide information and promote discussion on sustainable water management in urban areas among various sanitation stakeholders. The project involved public utilities, construction companies, public administrators, businesses, technical experts and professionals. (Source: BESSE in-depth interviews, IT)

Table 23 ANNEX: Immobility of the Institutional Actors

No.	Practice	Description
P28	**Funding mix approach**	Some research institutions are developing practices based on a funding mix. The use of various funding sources (such as public institutions, universities, enterprises, local authorities, private investors) minimises the risks taken by each partner and assures greater stability to the research process. (Source: BESSE in-depth interviews, BG, IT, NL, UK)
P29	**National programmes focused on single technologies**	Some governments are promoting national research programmes focused on single technologies in order to favour the development of frontier technologies requiring long-run financial support. In this way, companies and research institutions are not required to produce outputs in the short-run, as with other kinds of financing (such as with funds directly provided by utilities). (Source: BESSE in-depth interviews, NL)
P30	**Incentives for innovation**	A strategy found in promoting advanced waste treatment techniques is to give tax benefits or financial incentives to operators who adopt innovative technologies that improve on environmental standards established by law. State contributions would encourage companies to invest in this field. (Source: BESSE in-depth interviews, NL, UK)
P31	**Integrated management of the water cycle by a single utility**	It is an ever-spreading practice to give a single utility the management of the entire water cycle. This allows the utility to have an overall view of the problems to cope with and to better define their research and innovation needs to transfer to research institutions. (Source: BESSE In-depth Interviews, IT, NL)
P32	**Institutions specialised in the promotion and financing of water research**	Some institutions specialised in the promotion and financing of water research have been established in some countries. The creation of bodies of this kind makes it easier to coordinate national research efforts, to ensure continuity of the research strands, to bring out more systemic and relevant research demands and to facilitate the dissemination of information and new knowledge among sanitation players and stakeholders. (Source: BESSE in-depth interviews, NL, UK)
P33	**Establishment of a European platform on water and sanitation**	The EU has established the 'European water platform '. Its main aim is to bring together technological know-how, firms, regulators and financial institutions in order to establish a strategic agenda for leading technologies. Similar initiatives, also at national level, could be helpful in quantitatively and qualitatively improving the research on sanitation. (Source: BESSE in-depth interviews)
P34	**Strategic direction statement**	In the UK, to activate step-change projects, the regulator required water and sanitation companies to develop a strategic direction statement, providing for a road map for the next 25 years. In this way, companies are asked to identify the areas of innovation requiring major technological investments. (Source: BESSE in-depth interviews, UK)
P35	**National standards on carbon emission**	Still in the UK, the regulator established a target for water and sanitation companies to reduce their embodied carbon by 50%, in order to promote greater step-change in designing and building future plants and in selecting future technologies. (Source: BESSE in-depth interviews, UK)

P36	**Utilities' alliance for environmental sustainability**	In some countries, utilities have established forms of alliance to promote more sustainable approaches, especially by developing framework agreements aimed at promoting energy saving or the production of energy from waste water. (Source: BESSE in-depth interviews, NL)
P37	**Sustainability balance sheet**	Some utilities draw up a sustainability balance sheet which allows them to better check their progress and to establish annual objectives in terms of quality improvements and sustainable technologies. (Source: BESSE in-depth interviews, IT)

Table 24 ANNEX: Research Weaknesses

No.	Practice	Description
P38	**Selecting project coordinators able to assure a multidisciplinary approach**	In selecting their project coordinators, a company that produces innovative technologies for water depuration devoted specific attention to the capacity of candidates to be technically skilled to coordinate multidisciplinary work. This attention was justified by the fact that innovative plants require the collaboration of different types of professionals: engineers, metal workers, biologists, etc. (Source: BESSE in-depth interviews, IT)
P39	**Early definition of the application outputs expected of the research**	To have a closer link between research and practice, some research institutions promote an early definition of the expected application outputs. This helps to timely understand the different disciplinary skills to be mobilised. (Source: BESSE in-depth interviews, NL)
P40	**Early and strong involvement of end-users in research**	In order to create close links between research and practice, some research institutions developed a set of practices and strategies aimed at allowing an early and strong involvement of end-users in the research activity, even when the research project is expected to produce practical outputs only in the long-run. (BESSE in-depth interviews, NL)
P41	**Demand-driven research organisation**	A research organisation involves a group of different companies as members. This form of institutional involvement makes it a demand-driven organisation, where member companies define research problems to deal with. (BESSE in-depth interviews, NL)
P42	**BOT-Cooperation University-Company**	One of the practices identified is the so-called BOT-cooperation (Build, Operate, Transfer), a form of project financing in which financing comes from companies. Companies are interested in finding out whether new technologies actually work in practice, and fund research in practically oriented universities. Such companies can step in when cuts in the university budget could terminate some research programs. (BESSE in-depth interviews, NL)
P43	**Technology advisory groups**	One practice to support research/industry relations is the one revolving around the establishment of technology advisory groups, able to support companies in developing their own research. When companies identify a potential product or a possible technology they think is promising, they can ask for support from the advisory group, which helps them to evaluate the real potential of the product/technology. This procedure should be very useful for companies to reduce investment risks and to better orient their R&D activities. (BESSE in-depth interviews, UK)

P44	**In-house research centre**	A number of water and sanitation utilities set up their own in-house research centre. This institutional solution allowed them to develop research programmes strictly connected with the real problems they have to cope with. Some utilities established the in-house research centre by establishing a strategic alliance with external research centres, sometimes based abroad. (BESSE in-depth interviews, IT, UK)
P45	**Satellite R&D companies**	Many utilities make use of satellite research and development companies, which work on the frontline of sanitation research. Technicians and experts who work there keep up with the latest technological developments because they are also part of international research groups and have constant contacts with academia. (BESSE in-depth interviews, IT, NL)
P46	**Long-term experimentation**	Eight years ago, a university engaged in carrying out research programmes on water reuse acquired a field to carry out long-term trials. This allows researchers to more easily apply experimental results on a large scale, as soon as the research is completed. (BESSE in-depth interviews, IT)
P47	**Developing university-industry cooperation on research and patenting**	Within a research institution, various companies are involved in both financing and carrying out specific R&D programmes. Patents on new technologies developed by the research institutions are owned by the companies that have invested in that particular technology. (BESSE in-depth interviews, NL)
P48	**Platform for environmental knowledge**	A company that produces new technological solutions is working to create a single platform to store and make knowledge and experiences available, and covering the whole range of environmental protection issues. (Source: BESSE in depth interviews, IT)
P49	**Conferences and events bringing together research and industry**	Various companies that produce new technologies organise conferences to promote communication between different actors, in particular, academic institutions and industries. This approach has been borrowed from other sectors such as pharmaceuticals and the perfume industry, where these initiatives are widely used. It is an effective approach, since communication also includes cultural and scientific domains, not just commerce. (Source: BESSE in depth interviews, IT, UK)
P50	**External scouting**	Many companies cope with their knowledge and technological needs by primarily identifying qualified organisations that have already developed appropriate solutions. This implies a scouting activity carried out using a range of different tools, such as informal contacts with experts and companies, internet searches as well as traditional communication tools, such as fairs and conferences. Another common practice is to host workshops on innovative solutions. (Source: BESSE in depth interviews, BG, IT, UK)
P51	**Participatory scouting platform**	A water and sanitation utility launched a participatory platform open to anyone wishing to propose innovative ideas. Through a dedicated website, the utility can welcome and assess ideas, processes, technologies and materials from all stakeholders, whether in-house or external. (Source: BESSE in depth interviews, IT)
P52	**Involvement of young professional and researchers in scouting exercises**	An important knowledge scouting strategy is to valorise the role played by young members of staff, who are much more adept than older employees at identifying new technologies for the company. (Source: BESSE in depth interviews, IT)

IX

WBL RESHAPING THEIR INTERNAL KB PRACTICES (WP2)

This is an additional report, prepared by Maastricht University and Water Board Limburg (WBL, *Waterschapsbedrijf Limburg*) as a further step towards articulating the potential points of entry for the WBL towards reshaping their internal KB practices. The report reflects in particular on the experiences in developing the *Modulaire Duurzame Rioolwater Zuiverings Installatie* (MDR, Modular Sustainable Water Sanitation Plant).

Introduction

The European Commission is funding the collaborative project '**Brokering Environmentally Sustainable Sanitation for Europe**' (BESSE) under the environment subtheme (Enhancing connectivity between research and policy-making in sustainable development) of the Seventh Framework Programme. The project is a collaborative effort of academic, professional and non-governmental organisations. It aims to contribute to the Renewed, Sustainable Development Strategy of the European Union through the enhancement of the links between sanitation policy and research on sustainable sanitation development. The aims and objectives of the project are:

1. To establish what obstacles are preventing the dissemination of scientific and technical sanitation information;
2. To identify knowledge brokering (communication) methods that will enable the sanitation sectors to overcome these obstacles;
3. To start a learning process on knowledge brokerage in general, as a tool for the socialisation of Scientific and Technological Research (STR).

The main findings of the project have been summarised in a booklet entitled *Position Paper and Guidelines from the EU-FP7 BESSE project* (BESSE, 2012a). The booklet presents the highlights from the BESSE project in two inter-related lines of work. 'As a position paper it takes stock of European work on sustainable sanitation and on experiences with knowledge brokerage; as policy guidelines it advises on how knowledge brokerage can be shaped and enhanced, especially to innovate sustainable water sanitation' (BESSE, 2012, p.4)The document is valuable not only in terms of articulating a general framework for understanding the practice of knowledge brokerage (KB) for stakeholders in the field of water sanitation, but it can also be seen as a fresh starting point for the participating organisations within the BESSE project to continue their work in obtaining insights into KB mechanisms within their networks. While articulating the lessons learnt in conducting the BESSE project, the document enables an understanding of points of potential entry for the participating organisations to enhance their internal KB practices.

This report is a step in the direction of articulating the potential points of entry for the Water Board Limburg (WBL, *Waterschapsbedrijf Limburg*) towards reshaping their internal KB practices. Before establishing the form and the content of this report, we will briefly delve into the nature of WBL as an organisation and illustrate their reasons for commissioning this report. In turn, our illustration of these reasons will enable a deeper understanding of the context within which the report has been written and the purpose it aims to achieve.

WBL is a public organisation dealing with the treatment of wastewater, the transport of wastewater and the processing of sludge. WBL is funded by taxpayers' money, directly provided by the citizens and industries. Although it is a public organisation, WBL calls itself a company ('*bedrijf*') and works in a more or less business-like manner. Nevertheless, due to its political accountability and social responsibility, WBL and other Dutch water boards — who are responsible for wastewater treatment in The Netherlands — often state that they cannot afford to take financial risks or invest in ways that a private company would do. WBL is not a very large organisation and has approximately 150 employees. The majority of these employees have a technical background.

The Dutch part of the BESSE project was organised as a collaborative endeavour between The Department of Technology and Society Studies, Faculty of Arts and Social Sciences, Maastricht University (UM-STS team) and The Water Board Limburg (WBL team). The two teams – henceforth in this report indicated as 'the BESSE team' – were involved in the organisation of the BESSE Pilot Project in The Netherlands within WBL which culminated in the work package report entitled *Working towards Sustainable Sanitation in The Netherlands (BESSE Pilot Study WP6)* (BESSE, 2011). There were a plethora of activities that were organised during the Pilot Project to facilitate KB within WBL (*for a detailed documentation and analysis of these activities, please refer to the WP6 report*). With respect to these activities and the follow-up initiatives organised by the WBL, one of the insights mentioned in the *Position Paper* (BESSE, 2012a), affords a special mention. 'Knowledge brokerage is necessary for innovation. Without knowledge brokerage there is the risk that 'things do not get going'. Knowledge brokerage can in fact produce a 'chain reaction' in the processes of change, forming a 'critical mass' in demands for change among different actors. This function is even more critical when tendencies for change are particularly weak, as in the case of sanitation' (BESSE, 2012, p. 23).

The reason for this special mention is that after the completion of the Pilot Project, WBL has invested not only a lot of time but also substantial employee effort in developing a new building philosophy for waste water treatment plant called *Modulaire Duurzame Rioolwater Zuiverings Installatie* (MDR, Modular Sustainable Water Sanitation Plant). In an interview, Olaf Durlinger, Senior advisor wastewater infrastructure (WBL), mentioned that, 'We started thinking along the lines of MDR about four or five years ago. Our Director [E.M. (Guus) Pelzer, Director of WBL] said that we have been conventional plants for ages. Engineering firms and technology providers have come up with new ideas in the meantime that we haven't been able to implement. Our plants aren't built to adjust to new things. We build them for 40 to 50 years. And then, we demolish them to build new ones. He felt that there should be something that we can do to make this cycle shorter and so we discussed it a lot.' (Interview, 04/06/2012). While the focus on MDR has been articulated for a very long time within WBL, considerable inputs were made into the concept during the organisation of the Pilot Project and after its completion. The UM-STS team was not involved in the conceptualisation of MDR, but we believe that an increased focus on KB practices within WBL during the Pilot Project influenced the concretisation of the new building philosophy.

In the wake of the development of the MDR concept and the completion of the BESSE project, the objective of this report is two-fold:

1. To illustrate the relationship between Innovation and KB practices with a framework for enabling organisational innovation using KB and to contextualise the lessons learnt from BESSE for WBL

2. To illustrate the scope and effectiveness of these contextual lessons learnt using MDR concept as a case study. In this respect, the report will offer a brief documentation of how the MDR concept was developed within WBL and then, evaluate the processes used to achieve this innovation using the framework for enabling organisational innovation as established above.

The Pilot Project in The Netherlands has been considerably different in comparison to the Pilot Projects in Italy and Bulgaria. The focus of the Dutch Project was on a specific organisation instead of a network of organisations and explored internal organisational challenges to KB mechanisms. In this respect, the scale of KB mechanisms being studied was different. A combination of an ethnographic study of WBL's organisation and community, and an interventionist style of STS (Science, Technology and Society studies) research enabled the BESSE team to not only point out the exact nature of the problems with KB that WBL was facing, it has also enabled an understanding of the organisational culture of WBL. This understanding is a useful stepping stone for the

foundation of this report and it will inform the analysis of the contextual relationship between Innovation and KB with respect to WBL.

Studying Organisational Innovation in WBL and MDR

Most of the empirical data that has been presented in this report has been gathered by conducting qualitative interviews with five out of the seven members of the MDR Project team (*See Appendix I for the Topic Guide of these interviews*). This Project team was entrusted the task of conceptualising a new way of building wastewater treatment plants (WWTP) and has been working on this project from the initial brainstorming sessions organised in November, 2011 to the final presentation of the MDR concept to the Management team and the finalisation of the internal MDR report in the end of June, 2012. The MDR Project Members have been listed in Table xx (*in order of the chronology of the interviews*).

Section 2: Innovation via Knowledge Brokerage in WBL explores the innovation value chain established by Morten T. Hansen and Julian Birkinshaw (2007) to illustrate the phases wherein WBL can identify its strengths and weaknesses with respect to organisational innovation. The section will also list out the lessons learnt from the *Position Paper and Guidelines from the EU-FP7 BESSE project* (BESSE, 2012a) and document the interrelationship that can be observed in the practice of knowledge brokerage and sustenance of organisational innovation. This section will offer a set of heuristics for innovation and the theoretical foundation within which the organisation of the MDR project could be examined.

Section 3: Conceptualisation of MDR and its Organisation will start with a documentation of the process by which the new building philosophy encapsulated within MDR was finalised. It will then examine the facilitating and hindering factors to the process as identified by the interviewees. Finally, the heuristics of innovation as established in *Section 2* would be used for a critical analysis of the modus operandi of the MDR project.

Finally, ***Section 4: The Future of Knowledge Brokerage and Innovation in WBL*** will combine the insights gathered from the theoretical foundation in *Section 2* and its application in *Section 3* to offer a set of guidelines that can be employed by WBL. The combination will be illustrated in conjugation with from the policy guidelines as suggested by the *Position Paper* (BESSE, 2012a) contextualised with respect to WBL.

Innovation as a professional practice has always been perceived as making commercially viable use of new ideas, but this notion seems to be an incomplete narrative. There is a plurality of factors that enable innovation and many of them don't necessarily originate from

Table 25: List of the MDR Project Team Members

Interviewee	Function and affiliation	Date of Interview
Olaf Durlinger	Senior Advisor wastewater infrastructure (WBL), MDR Project Leader and member of the BESSE team	4th June, 2012
Ad de Man	Senior engineer (WBL)	6th June, 2012
Jan Janssen	Senior Advisor W&E (mechanical and electro-technical engineering; WBL)	12th June, 2012
Andries Vonken	Innovation engineer (WBL)	14th June, 2012
John Belleflamme	Cost Engineer and Procurement Advisor (WBL)	14th June, 2012
Roger Crousen		---
Frank Verkuijlen	Maintenance Engineer (WBL)	---

the need for commercial success. While the ultimate goal of an innovation might be the development of commercially viable new ideas, the ways to reach that ultimate goal requires a set of intermediary steps that also entail the tailoring of knowledge brokerage practices to the needs of an organisational culture. This report in its conceptualisation combines two different activities – innovation and knowledge brokerage – to illustrate that an organisational interest in any of these two activities will potentially have similar impact on the work-culture of the organisation.

Innovation is messy and any narrative of innovation is incomplete without tackling the ambiguity around it. The origins of this ambiguity lie within the fact that innovation is not a completely pervasive phenomenon and neither is it completely sporadic. While we can define processes to institutionalise innovation, we cannot deny that the next innovation might also originate from an employee's curiosity to tinker with an organisation's well-established existing products / services / processes. Hence, this report should not be seen as a well-defined process that can be implemented within WBL to foster innovation and knowledge brokerage. Rather, this report and its findings should be seen as a tool-kit with a multiplicity of tools that can be contextually employed to enhance the organisational culture of WBL towards innovation and knowledge brokerage.

Innovation via Knowledge Brokerage in WBL

> 'There is no universal solution for organisations wanting to improve their ability to generate, develop, and disseminate new ideas. Every firm faces its own challenges in this regard.
>
> Managers need to take an end-to-end view of their innovation efforts, pinpoint their particular weaknesses, and tailor innovation best practices as appropriate to address the deficiencies' (Hansen & Birkinshaw, 2007, p. 122).

Despite WBL's insistence on being called a company and its operation in a more or less business-like manner, the challenges to innovation within WBL are embedded within its political accountability and social responsibility as a public organisation. We have already established in *BESSE Pilot Study WP6* (BESSE, 2011) that the challenges to incorporating new ideas within the organisational culture of WBL lie in an explicit focus on mitigating financial risks and a lack of knowledge brokerage within the organisation. Within these limitations, WBL also presents itself as a fertile ground for innovation with multi-disciplinarity of its employee base and its enthusiasm towards building the most sustainable waste water treatment plant of Europe.

Relationship between Innovation and Knowledge Brokerage

Before we begin our analysis of the MDR case study and the organisational culture of WBL with respect to innovation, it is pertinent to establish the relationship between knowledge brokerage and innovation within organisations. In his analysis of intermediary firms that act as knowledge brokers between different industries which may either be producers or users of knowledge, Andrew B. Hargadon, Professor of Technology Management at the Graduate School of Management at University of California, Davis, argues that, 'Knowledge brokers are modern invention factories: their output consists solely of innovative solutions to novel problems. [...] In short, these firms seek strategic advantage by gaining access to a wide variety of industries. They exploit this position to learn about and link a wide range of existing problems and solutions, creating innovative solutions in the form of new combinations of these existing ideas' (Hargadon, 1998, p. 210). But, knowledge brokerage is not limited to individual firms that operate in that capacity.

In his introductory note of knowledge brokerage in the *Resource File on the BESSE Project* (BESSE, 2012b), Wiebe Bijker summarises the different aspects of knowledge brokerage by breaking the concept into its

component words:

- *Knowledge*: includes at least scientific knowledge, users knowledge, and (ideas for) technological innovation.
- *Brokerage*: is the intermediating (or 'boundary') work between places (or individuals or organisations) with more knowledge and less knowledge' (BESSE, 2012b, p. 10).

Using this summarisation, we can conclude that the intermediating work of brokerage doesn't necessarily have to carried out by an external knowledge brokerage firm, it could very well be carried out by employees within an organisation for inter-departmental brokering of knowledge or dissemination of knowledge from external sources within the organisation.

Combining Bijker's summarisation and Hargadon's analysis, we argue that employees in a position to act as knowledge brokers within an organisation can also potentially 'exploit this position to learn about and link a wide range of existing problems and solutions, creating innovative solutions in the form of new combinations of these existing ideas' (Hargadon, 1998, p. 210). In this sense, knowledge brokers are essential to the organisational culture of innovation for any firm.

In the context of the MDR case study, the role of the MDR Project Team can also be interpreted as being one of knowledge brokerage apart from being the team working on innovations with WBL. As Andries Vonken specified, 'Within the Water Board business, MDR is quite new because they have a history of building everything large, very robust, under the ground and inflexible. But, for me, MDR is looking a lot like the industrial way of building WWTPs. The industrial way of building is more above the ground and not for 40-50 years. [...] There are two different approaches depending on what history you have and the commercial way of building WWTPs... they are not as heavy in design and construction as in the Water Board sector' (Interview, 14/06/2012). The MDR in its conceptualisation seems to be a new combination of existing ideas, transposing the industrial way of building WWTPs onto the Water Board way. Hence, the MDR concept is both an innovation as well as an act of knowledge brokerage.

Characteristics of Innovative Organisations

Before heuristically establishing a certain set of pointers that will enable an analysis of ways of promoting innovation within WBL using the innovation value chain established by Morten T. Hansen and Julian Birkinshaw (2007), we will first illustrate a set of characteristics of innovative organisations identified by Sandford Borins (2006), Professor of Public Management at the University of Toronto. His report 'uses as its database large samples of applications to two major public management innovation awards, one in the United States and the other in the Commonwealth. The experience of these innovators (has been} analysed to develop recommendations for aspiring public sector innovators' (Borins, 2006, p.4). We will list out the characteristics of innovative organisations that he identifies and then contextualise them with respect to knowledge brokerage and innovation in WBL.

- 'An innovative culture needs support from the top. It can come in the form of establishing organisational priorities to guide innovation, recognition for innovators, protection of innovators from central agency constraints, and granting the latitude to experiment' (Borins, 2006, p. 5). With respect to sustainability as a new idea for innovation within WBL, we have inferred a mixed response in terms of this support. While ideation is encouraged by the Management Team, a follow-up action beyond the establishment of sustainability as an organisational priority was missing. Though, the situation has changed dramatically with respect to the conceptualisation of MDR wherein the support from the top was clearly visible, the establishment of this support as a norm within WBL requires further concretisation.
- 'Increased rewards to innovative individuals may

include financial compensation — for example, performance-related pay and gain-sharing — or non-monetary awards or recognition' (Borins, 2006, p. 5). This characteristic has not been explored in our research explicitly, but in terms of recognition, *BESSE Pilot Study WP6* report documents instances of double work done within the organisation. In this respect, appropriate knowledge brokerage mechanisms with WBL could enable recognition of employees in terms of their work.

- 'Individual innovators made clear that lack of resources for innovations was a serious constraint. One response to this is to establish a central innovation fund to support innovative ideas within the public sector. Financial management reforms also create the possibility of enhanced internal funding for innovation within all agencies' (Borins, 2006, p. 5). Financial concerns are the most cited criteria by the Management Team in evaluating ideas exploring sustainable alternatives. Even in the conceptualisation of MDR, one of the main drivers of the brainstorming sessions was reduction of costs by 10-20%. On the other hand, none of the Project team members have indicated a lack of allotment of resources in the organisation of the sessions for the conceptualisation of MDR. In this respect, using the MDR case study, we can conclude that WBL is willing to support ideation and development of new ideas generated by its employees.

- 'Because innovation often depends on the ability to see things differently, diversity in terms of the backgrounds and ways of thinking of an organisation's members will enhance its innovativeness' (Borins, 2006, p. 5). In *BESSE Pilot Study WP6* report, we have already established access to a multi-disciplinary team and varieties of expertise as a facilitating factor for knowledge brokerage in WBL. 'WBL already has access to a multi-disciplinary team with members having expertise in various aspects of waste-water treatment plant. Though, WBL is not a technology developer, it has enough in-house expertise to evaluate options in terms of sustainability' (BESSE, 2011, p. 27). Such a diverse employee base was also effectively used in the making of the Project Team that conceptualised MDR. WBL is very-well equipped with respect to this characteristic of innovative organisations.

- 'Innovative organisations are effective at seeking out information from the outside, for example, by benchmarking, making site visits, and participating in professional networks. They are also effective at sharing this information internally' (Borins, 2006, p. 5). WBL has been participating in external forums and setting up very effective networks with its stakeholders. This can be seen explicitly in terms of the workshops organised in collaboration with universities such as TU Delft and other Water Boards such as Water Board Delfland.

The problem for WBL lies in the internal dissemination of information. This aspect has been illustrated as a hindering factor in the *BESSE Pilot Study WP6* report. 'Information exchange and knowledge management have been cited at all hierarchical levels within WBL as a problem. Whether it is members of the management team who say that they have a limited understanding of the nature of the activities conducted by the team promoting 'sustainable thinking' in WBL or it is individual employees who report instances of double work and unread documents, the problem seems to be embedded in a lack of communication' (BESSE, 2011, p. 27). Even during the conceptualisation of MDR, the secrecy around the activities of the Project Team was cited by all members as being problematic. Focussing on this characteristic will be one of the major challenges for WBL's future as an innovative organisation.

- 'Innovative organisations draw ideas from people at all levels' (Borins, 2006, p. 5). This characteristic co-relates with the internal dissemination of information within WBL. The *WP6* report highlights the problems encountered by individual WBL employees as potential knowledge brokers. The common

observations highlighted by the *WP6* report are as follows:

- ◊ 'They do not think of themselves as being in a legitimate position to influence sustainability thinking within WBL.
- ◊ This decreases their willingness to act as a knowledge broker on sustainability issues. This, in turn, does not help the first group of sustainability promoters.
- ◊ To effectively incorporate sustainability thinking in WBL's daily work practices, effective knowledge management is crucial to enable individual team members to share their ideas and research results' (BESSE, 2011, p. 16).

In the context of WBL, with their mission strategy document clearly specifying that 'better means sustainable', this attitude towards sustainability thinking can be interpreted as the employee attitude towards innovating sustainable alternatives in the development of WWTPs. In this sense, WBL will have to work towards encouraging and supporting ideas from people at all levels.

- 'Innovative organisations are effective at experimenting and evaluating their experiments. They recognise that failures are possible, and have lowered the cost to their staff of honourable failures. They continue with their successes and discontinue their failures' (Borins, 2006, p. 5). While as a characteristic this aspect of innovative organisations is very commonsensical, the public organisations with their risk aversion find this aspect to be the most problematic to implement and sustain. This can be clearly inferred from the section on *The Management Team as a potential knowledge broker* in the *WP6* report (BESSE, 2011, p. 14-15). On the other hand, the MDR case study offers optimism in this respect. With the support of the Management Team and the freedom to employ the Blue Ocean Strategy (Kim Chan & Mauborgne, 2005) referred to by Olaf Durlinger as 'the green field method' (Interview, 04/06/2012), the MDR concept was created with an explicit focus on open experimentation with the design and construction of WWTPs. Hence, WBL's challenge in the future would be to sustain such experimentation and involve more of its employees into its organisational culture of innovation.

The Innovation Value Chain

Morten T. Hansen, Professor in Entrepreneurship at INSEAD and Julian Birkinshaw, Professor of Strategy and Entrepreneurship at London Business School, have devised an innovation value chain which presents innovation 'as a sequential, three-phase process that involves idea generation, idea development, and the diffusion of developed concepts. Across all the phases, managers must perform six critical tasks—internal sourcing, cross-unit sourcing, external sourcing, selection, development, and companywide spread of the idea. Each is a link in the chain' (Hansen & Birkinshaw, 2007, p. 122). Their research is a result of the 'findings of five large research projects on innovation that [they] undertook over the past decade [1997-2007]. [They] interviewed more than 130 executives from over 30 multinationals in North America and Europe. [They] also surveyed 4,000 nonexecutive employees in 15 multinationals, and [they] analysed innovation effectiveness in 120 new -product development projects and 100 corporate venturing units' (Hansen & Birkinshaw, 2007, p. 122). Their framework of the innovation value chain will offer the theoretical foundation for our analysis of the organisational culture of innovation within WBL.

Hansen and Birkinshaw (2007) illustrate three phases of process of organisational innovation in their research which are as follows:

- **Idea Generation:** The process of generating innovative ideas that can be examined for further devel-

opment. This can happen within a department, across departments in a company, or from outside the firm.

- **Idea Conversion:** The process of selecting ideas that need to be further developed and funded within the organisation to create new business products and processes.
- **Idea Diffusion:** The process of disseminating ideas that have been sourced, vetted, funded, and developed into relevant constituencies within the organisation to support and spread the new products, businesses, and practices across desirable geographic locations, channels, and ultimately customers.

They have summarised their research results in a table which has been illustrated in Table 26. It explores how organisations can identify the weakest and strongest links in their innovation value chain.

Viewing innovation as an end-to-end process rather than focusing on a part allows you to spot both the weakest and the strongest links' (Hansen & Birkinshaw, 2007, p. 124).

Hansen and Birkinshaw's research (2007, p. 129) also offers a questionnaire (*see Appendix II*) for evaluating an organisation's innovation performance. Based on these questions and how they are evaluated, we have created a set of heuristics to identify the weakest and strongest links within the innovation value chain of an organisation that are applicable for WBL. We will list them out with respect each of the phases and later in *Section 4: The Future of Knowledge Brokerage and Innovation in WBL,* we will use them for our analysis of the innovative potential of WBL.

These heuristics will first be analysed theoretically in combination with the lessons learnt from the BESSE project to establish how insights into KB offered by BES-

Table 26: The Innovation Value Chain: An Integrated Flow

	Idea Generation			**Conversion**		**Diffusion**
	In-House	Cross-Pollination	External	Selection	Development	Spread
	Creation within a department	Collaboration across departments	Collaboration with parties outside the firm	Screening and initial funding	Movement from idea to first result	Dissemination across the organisation
Key Questions	Do people in our unit create good ideas on their own?	Do we create good ideas by working across the company?	Do we source enough good ideas from outside the firm?	Are we good at screening and funding new ideas?	Are we good at turning ideas into viable products, businesses, and best practices?	Are we good at diffusing developed ideas across the firm?
Key Performance Indicators	Number of high-quality ideas generated within a department.	Number of high-quality ideas generated across departments.	Number of high-quality ideas generated from outside the firm.	Percentage of all ideas generated that end up being selected and funded.	Percentage of funded ideas that lead to revenues; number of months to first sale.	Percentage of penetration in desired markets, channels, customer groups; number of months to full diffusion.

SE can be co-related with organisational innovation performance with respect to WBL.

The Lessons Learnt on KB from BESSE vis-à-vis the Innovation Value Chain

The *Position Paper* (BESSE, 2012a, p. 22-28) offers a detailed analysis of the lessons learnt from the BESSE project. In this report, we will illustrate these lessons learnt and highlight their relevance vis-à-vis the phases specified by the innovation value chain as established in *Section 2.2*. We will first deal with the complete innovation value chain and then, each of the phases sequentially and identify the lessons learnt that are applicable for both of them.

In the context of the complete *Innovation Value Chain*, we have identified a set of general lessons learnt that can be applied to all the phases of the innovation process. For innovation to be a cultural characteristic of an organisation, the following lessons learnt should be seen as a starting point for understanding and applying KB processes within that organisation.

- **Knowledge brokerage is a widespread social process.** KB should be understood as 'a widespread and continuous social process, normally carried out—often without realising it—by people other than professional knowledge brokers such as, for example, researchers, utilities managers and operators, civil society representatives, local authorities and technology suppliers' (BESSE, 2012a, p. 22). This lesson reiterates our initial claim that knowledge brokerage is not necessarily an activity orchestrated by professional KB firms but can be carried out individual employees of any organisation.

- **Knowledge brokerage by itself is not sufficient for innovation to take place.** The pilot projects organised under BESSE have shown that 'the implementation of knowledge brokering actions is not enough to reverse the current trend of opposition to innovation in sanitation. [...] The factors underly-

Table 27: Heuristics for each Phase of the Innovation Value Chain

Components:	Heuristics:
In-house idea generation	• Discussion on novel ideas among employees is directly related to the organisational culture of a firm that can either encourage it or discourage it. • For successful innovation within firms, employees need to be inclined towards coming up with good ideas on their own.
Cross-pollination among departments	• Innovation project teams should ideally involve team members from different departments. • For successful innovation within firms, employees should be enthusiastic towards collaboration on projects across departments.
External sourcing of ideas	• Employees should beware of 'not-invented-here' attitude, which implies that ideas from outside aren't considered as valuable as those invented within.
Selection	• The rules for investment in new projects and ideas should be well-established, transparent and easy to negotiate. • Organisations should be open to the fact that investment in new ideas can be a risky endeavour.
Development	• Projects involving development of new ideas should have a set timeframe and they should be accomplished within it. • Organisations should be flexible enough to abandon projects and switch to the ones that offer more traction in developing business.
Diffusion	• The timeframe for the roll-out of the new product/business after its development should be as small as possible. • The dissemination of the new product should happen across all possible channels and geographical regions as applicable.

ing the lack of innovation in sanitation are deep and widespread. It would be illusory and unrealistic to imagine that innovation can be achieved only through knowledge brokerage' (BESSE, 2012a, p. 22 -23). While knowledge brokerage is essential to the innovation value chain, it should not be seen as a universal solution to making an organisation innovative.

- **Knowledge brokerage is necessary for innovation.** We have already dealt with this lesson in the *Introduction* of this report with a special mention.

- **Systemacity.** 'Knowledge brokerage has a better chance of success if it is part of a systematic effort, which takes into account all aspects involved, which is continuous over time and which, as far as possible, follows a plan of action' (BESSE, 2012a, p. 23). Borins (2006, p. 9-11) in his report on challenges to innovation within public organisations has also identified a similar systems approach to be one of the building blocks for innovation. In this context, this report with a systematic view on innovation as phases will offer a comprehensive analysis of how individual lesson learnt on KB processes are applicable to different phases of innovation.

- **Integration.** KB 'works best when sanitation stakeholders are part of an integrated process, creating interaction and fostering negotiation' (BESSE, 2012a, p. 23-24). This insight can be seen as synonymous with the observation made by Rosabeth Kanter, Professor at Harvard Business School specialising in strategy, innovation, and leadership for change that 'regardless of the origin of innovations, they inevitably send out ripples and reverberations to other organisational units, whose behaviour may be required to change in the light of the needs of innovations, or whose cooperation is necessary if an innovation is to be fully developed or exploited' (Kanter, 1988, p. 171). Integration remains a necessary condition for both innovation as well as KB.

- **Adaptation of scale.** The scale of KB interventions can range from a single department and an organisation to a network of organisations and even whole sections of society (BESSE, 2012a, p. 24). Hence in the context of WBL, it becomes essential to contextualise the lessons learnt about KB to the scale at which they are applicable. Hence, after this point, we will explore each of the phases of the innovation value chain sequentially and identify lessons that are applicable for each of them.

With respect to *Phase 1: Idea Generation,* the focus of innovation management is on coming up with new ideas that need to be developed. This can be done via in-house idea generation within a department, cross-pollination among departments or sourcing of ideas from outside the organisation. One of the general lessons learnt on KB that is applicable to this phase is the **plurality of perspectives**. 'Experimentation has shown that brokerage can be improved by looking at problems and knowledge from different angles and perspectives' (BESSE, 2012a, p. 27). In this context, a new idea may emanate from a diversity of viewpoints that are applied as a problem-solving methodology. We will now break up the process of the Idea Generation into its three components and analyse which lessons are applicable at what scale:

- In-House Idea Generation: With respect to collaboration within a department of an organisation, two of the lessons listed in the report are of primary importance.

    - ◊ **Reflexivity.** 'Knowledge brokerage works well if it can improve reflexive capacity in sanitation actors, i.e. a more open attitude towards the discussion of problems and an awareness of the importance of knowledge to solve them' (BESSE, 2012a, p. 25). This open attitude is important at the level of employees within a department because once it is appropriated at this level, such reflexivity will automatically emerge in inter

-departmental collaborations as well as while working with external organisations. **Related heuristic from *Section 2.2*:** *For successful innovation within firms, employees need to be inclined towards coming up with good ideas on their own*.

◊ **Exploiting the local dimension.** 'In promoting knowledge brokerage, we have seen how important it is to capitalise on the local dimension' (BESSE, 2012a, p. 28). Discussions about the uncertainty of new ideas require the comfort of familiarity between people. Within organisations, it is imperative to look within a department for new ideas first before going into the unfamiliar space of other departments and external sources of inspiration. Though, it may be necessary at times to collaborate with the outside world, a primary intra-department focus will encourage trust and recognition within the department. **Related heuristic from *Section 2.2*:** *Discussion on novel ideas among employees is directly related to the organisational culture of a firm that can either encourage it or discourage it.*

- Cross-pollination among departments: With respect to inter-departmental collaboration, the following two lessons listed in the report should be considered.

◊ **Plurality of knowledge.** 'Any sanitation intervention requires different fields of knowledge and not only knowledge of scientific or technological nature. [...] In fact, what became clear is that scientific and technological knowledge is becoming increasingly dependent on other types of knowledge (procedural, organisational, social, regulatory, etc), without which the scientific knowledge is more or less useless' (BESSE, 2012a, p. 25). The insight that needs to be recognised with this lesson is that the problems that an organisation such as WBL faces often require a multi-disciplinary effort and collaboration across departments.
Related heuristic from *Section 2.2*: *Innovation project teams should ideally involve team members from different departments.*

◊ **Participatory Approach.** 'Knowledge brokerage cannot be accomplished 'from above'. The simple dissemination of knowledge does not work. A participatory approach is needed — one that facilitates the personal and emotional involvement of everyone. [...] By planning, designing and acquiring new knowledge together, it is easier for stakeholders to establish ownership of the initiative, and to get involved in reducing opposition and obstacles.' (BESSE, 2012a, p. 26). In this sense, collaboration across different departments of a firm becomes quintessential for the generation of new ideas and their further development.

◊ **Exploiting the local dimension.** This lesson has to be reiterated here again because the scale of the application of this lesson has changed. While looking for ideas, it is again imperative to look within the organisation first before looking at external sources of inspiration. It will encourage confidence, trust and recognition among employees within the organisation and lead to a more fertile foundation for discussion with internal ownership of ideas. **Related heuristic from *Section 2.2*:** *For successful innovation within firms, employees should be enthusiastic towards collaboration on projects across departments.* This heuristic can be seen as a combination of the lessons b. Participatory Approach and c. Exploiting the local dimension.

- External sourcing of ideas: With respect to collaboration with parties outside the firm, the following lesson is the most applicable.

    ◊ **Convergence of supply and demand:** 'Those who seek new knowledge do not always know what knowledge they are actually looking for, while those offering new knowledge do not know exactly for what and whom it will be useful' (BESSE, 2012a, p. 24). KB as an activity is precisely targeted towards this problem. In this sense, the ideas external to the organisation that are ultimately used for innovative solutions to a problem might not necessarily be created for solving that particular problem. Hence, it becomes essential for employees to be open to external ideas and broaden their sense of how to use them so that they do not disregard external ideas that don't necessarily address the problem at their hands. **Related heuristic from *Section 2.2*:** *Employees should beware of 'not-invented-here' attitude, which implies that ideas from outside aren't considered as valuable as those invented within.*

With respect to *Phase 2: Idea Conversion,* attention is given to the screening and funding of new ideas that exhibit potential after *Phase 1* and their development into viable products, services or businesses. We will again break down this phase into its constituent components and look at each of them individually.

- Selection: The following lessons from the report are useful in the context of screening and funding of new ideas.

    ◊ **Preliminary analysis of knowledge needs:** This lesson has been illustrated using the WBL case study in the Position paper. 'More effective action can be achieved by conducting a preliminary analysis of the cognitive needs of all stakeholders (Maastricht) by using different instruments (meetings, production and discussion of documents, in-depth interviews), so that knowledge needs may be determined in advance as accurately as possible' (BESSE, 2012a, p. 26). The screening of new ideas would be easier if the firm is already aware of its knowledge needs. A dissemination of this preliminary analysis within the firm would enable a more transparent mechanism of evaluating the ideas generated within the firm.

    ◊ **Transparency:** 'The approaches based on transparency and full information sharing among stakeholders were found to be the most effective tools for building cohesion around technology transfer' (BESSE, 2012a, p. 28). This insight is equally applicable to building cohesion around screening and funding of new ideas within a firm. **Related heuristic from *Section 2.2*:** *The rules for investment in new projects and ideas should be well-established, transparent and easy to negotiate.* This heuristic can be seen as a combination of the lessons a. Preliminary analysis of knowledge needs and b. Transparency.

    ◊ **Monitoring:** The position paper promotes monitoring as a periodic activity involving all the stakeholders. With respect to WBL, the scale of the application of this lesson should first be considered at the level of internal monitoring. Monitoring 'highlights the actions already carried out and what remains to be done; secondly, it means that problems, opposition, conflicts or differences of opinion can be spotted and dealt with at an early stage' (BESSE, 2012a, p. 28). Periodic internal monitoring will enable a better understanding of the new ideas being discussed within the organisation and

would enable a faster screening of these ideas. Monitoring also implies that KB activities are prone to situations of opposition, conflicts and differences of opinions and hence, they are not risk-free in their application. Similar situations will be encountered while screening and funding new ideas. In this sense, both of these activities are a risky endeavour.

◊ **Related heuristic from *Section 2.2*:** *Organisations should be open to the fact that investment in new ideas can be a risky endeavour.*

- Development: For concretisation of ideas into viable products, businesses, services or an organisational way of operating, the following lessons learnt are the most useful.

  ◊ **Iterative interaction:** 'It is impossible to transfer complex knowledge through single, individual meetings or initiatives' (BESSE, 2012a, p. 27). Whether it is sharing of new knowledge or development of screened ideas into viable products, the processes that enable these activities (meetings, workshops, brainstorming sessions, etc.) require time in terms of understanding the problems that they address and the viability of their application. But, these processes do need a well-established timeframe within which they need to be accomplished, so that the results of the application of new knowledge and the development of screened ideas are visible and recognised within the firm. A good estimation of the time required for these processes is essential for the innovation performance of an organization.

  ◊ **Related heuristic from *Section 2.2*:** *Projects involving development of new ideas should have a set timeframe and they should be accomplished within it.*

  ◊ **Flexibility:** 'Adopting a flexible approach that proceeds by trial and error seems to be the most effective method when the situation is one of opposition and conflicting interests such as that of brokering knowledge in sanitation' (BESSE, 2012a, p. 27). This insight can also be seen as a way of negotiating which ideas are funded and developed into viable products. **Related heuristic from *Section 2.2*:** *Organisations should be flexible enough to abandon projects and switch to the ones that offer more traction in developing business.*

With respect to *Phase 3: Idea Diffusion* which implies spreading the developed ideas within and outside an organisation, the focus is on leveraging the network of stakeholders of a firm to facilitate the appropriation of an innovative solution. The *Position Paper* (BESSE, 2012a) also offers a set of lessons learnt in this regard which have been mentioned below:

- **Brokerage case studies.** It is 'useful to identify the obstacles and enablers encountered by brokerage in previous experiences, so as to anticipate any problems in the new situation' (BESSE, 2012a, p. 26). Previous experiences with the roll-out of innovative solutions or new knowledge should be considered a primary source of information with respect to estimating how individual stakeholders within the network in which the firm operates will react to a new fully-developed business plan resulting from *Phase 2*.

- **Brokerage survey.** 'A useful tool to facilitate knowledge brokerage is to explore — through a series of preliminary meetings — the views of different stakeholders' (BESSE, 2012a, p. 26). One of the ways of approaching the network of an organisation and influence their willingness to appro-

priate an innovative solution is to simplify the idea of the solution and gauge how these stakeholders react to the possibility of a full-fledged implementation of the idea. It will enable identification of key players within different organisations involved who can influence the decision-making processes around appropriation of the idea.

- **Visibility of the benefits of new knowledge.** 'One of the most effective instruments was the organisation of demonstrations to give a 'concrete' form to the benefits of the new knowledge to be introduced' (BESSE, 2012a, p. 28). The visibility of the benefits of a new idea is the simplest way of ensuring its appropriation. In this sense, the time taken for the roll-out and the scale of its application become important factors for consideration. The lesser the time taken and the bigger the scale, the better is the visibility of the benefits of the innovation.
  Related heuristic from *Section 2.2*:
  The timeframe for the roll-out of the new product/business after its development should be as small as possible.
  The dissemination of the new product should happen across all possible channels and geographical regions as applicable.

- **Transparency.** This lesson needs to be reiterated here again because again the scale of its application has expanded from within the organisation to the network of stakeholders within which the organisation operates. Building cohesion on the appropriation of innovative solutions requires transparency in sharing information about how the solution works and its advantages as well as disadvantages. Transparency and full information exchange should be a norm for any organisation willing to enhance their innovation performance.

To conclude this section, our illustration of the lessons learnt within the sequential, three-phase process of innovation has been summarised in Table 4.

While offering an alternative classification of lessons learnt from BESSE in Table 4, we are offering a different interpretation of how the lessons learnt on KB can be contextualised with respect to promoting innovation within a firm. Reverting back to the quote with which we started this section, just as 'there is no universal solution for organisations wanting to improve their ability to generate, develop, and disseminate new ideas' (Hansen & Birkinshaw, 2007, p. 122), there is also no single interpretation of the implications of these lessons learnt that will have universal application. Each firm/network of organisations needs to contextualise the implications of these lessons with respect to their own organisational/network culture. In this respect, we have created a theoretical framework as to how these implications can be rationalised within the Innovation Value Chain. The rest of the sections of this report will explore how this framework could be applied to the organisational culture of WBL.

Conceptualisation of MDR and its Organisation

Before illustrating the nature of MDR and how it was organised within WBL, it is necessary to understand the MDR can only be seen as a specific case study of the application of the Innovation Value Chain and does not accommodate for all the constituent components of its phases.

MDR was conceptualised by a Project Team which had members from different departments of WBL and is representative of the component of *Cross-pollination among departments* within the **Idea Generation phase**. The component of *In-house Idea Generation* is not clearly visible in MDR and we will not offer any insights on this component using this case study. On the other hand, MDR shows clear signs of engagement with the outside world for sourcing ideas and hence, we will explore how the component of *External sourcing of ideas* worked in this context.

Table 28: Lessons Learnt on KB from BESSE vis-à-vis the Innovation Value Chain

Generally Applicable Lessons Learnt with respect to all the Phases of Innovation			
KB is a widespread social process KB is necessary for innovation. Systemacity		KB by itself is not sufficient for innovation to take place. Integration Adaptation of scale	
Phase	**Constituent components**	**Lessons Learnt**	**Heuristics**
Idea Generation	In-house idea generation	Reflexivity	For successful innovation within firms, employees need to be inclined towards coming up with good ideas on their own.
		Exploiting the local dimension	Discussion on novel ideas among employees is directly related to the organisational culture of a firm that can either encourage it or discourage it.
	Cross-pollination among departments	Plurality of knowledge	Innovation project teams should ideally involve team members from different departments.
		Participatory Approach	For successful innovation within firms, employees should be enthusiastic towards collaboration on projects across departments.
		Exploiting the local dimension	
	External sourcing of ideas	Convergence of supply and demand	Employees should beware of 'not-invented-here' attitude, which implies that ideas from outside aren't considered as valuable as those invented within.
Idea Conversion	Selection	Preliminary analysis of knowledge needs	The rules for investment in new projects and ideas should be well-established, transparent and easy to negotiate.
		Transparency	
		Monitoring	Organisations should be open to the fact that investment in new ideas can be a risky endeavour.
	Development	Iterative interaction	Projects involving development of new ideas should have a set timeframe and they should be accomplished within it.
		Flexibility	Organisations should be flexible enough to abandon projects and switch to the ones that offer more traction in developing business.
Idea Diffusion	Spread	Brokerage case studies	
		Brokerage survey	
		Visibility of the benefits of new knowledge	The timeframe for the roll-out of the new product/business after its development should be as small as possible.
			The dissemination of the new product should happen across all possible channels and geographical regions as applicable.
		Transparency	

For **Idea Conversion phase**, the component of *Selection* cannot be adequately addressed using this case study because the Project Team was given a very specific task of focusing on the design of the WWTP and coming up with a new building philosophy. During the interviews, the team members also did not specifically illustrate the presence of a plurality of ideas around the conceptualisation of this building philosophy. They indicated that the development of MDR was a process of incremental additions wherein the broad ideas initiated by the director of WBL were slowly concretised. Hence, the process of screening ideas and the reasons for abandoning ideas that didn't work in the context of MDR cannot be illustrated. We will illustrate the component of *Development* in this respect and illustrate the kind of support provided by the Management to the Project Team.

Ultimately, the MDR concept is still within the **Idea Diffusion phase**. We will highlight the activities of the Project Team and the Management for this phase and the uncertainty of the activities to follow that have been indicated by the Project Team.

What is MDR?

> 'MDR is not a new concept for a certain kind of technology [with respect to WWTPs]. So, we are not going to build something completely new. It's more of a new concept in building and designing [a wastewater treatment] plant.' (Interview with Olaf Durlinger, 04/06/2012)

The MDR concept is primarily a new way of designing WWTPs that originates from the context of the following requirements:

- 'Ability to make adaptations to the design of the WWTP to accommodate the technological innovations in the field as quickly as possible.
- To make the lifecycle of a WWTP including its building as well as maintenance as cheap as possible.
- To reduce the time it takes to build or change the design of a WWTP' (Interview with Olaf Durlinger, 04/06/2012).

In this context, the WBL report on MDR and its development as a business case (WBL, 2012) begins by introducing MDR in a direct opposition to traditional WWTP. It states that unlike traditional sewage treatment plants, the modular nature of the MDR makes it possible to build municipal and industrial wastewater treatment systems in a flexible, inexpensive, and sustainable way to adapt to the changing environmental conditions and quickly respond to innovations (WBL, 2012, p. 8). This modularity is embedded within the design and the construction of the plant which is divided into three major parts:

- The Feed Step (which will be referred to in this report as the Front-train)
- The Purification Step (referred to as the Mid-train)
- The Follow-up Step of treating effluents (referred to as the End-train) (WBL, 2012, p. 17)

The WBL report argues that the innovative nature of the MDR is expressed primarily in the design and construction of the Front-train and the Mid-train of the installation. These steps are then described in detail and subjected to a financial analysis for consideration by the Management. The End-train is summarized as a possibility for further research and is not included in the financial considerations (WBL, 2012, p. 17).

The Front-train is characterised by the following elements (WBL, 2012, p. 17-18):

- A central channel which connects the sewage flow between the machines and apparatus.
- The machines and devices branches into the centrally installed gutter. This allows these machines to be moved and replaced quickly and easily based on the so-called Plug and Play principle. This arrangement also enables the branches to be temporarily

closed with ease.

- The central channel is made up of canvas parts of fixed length and shape;
- Terminals on the channel have the same dimensions;
- The machines at the terminals are similar to the ones at any conventional sewage treatment plants. There are no special machine adjustments that are required in implementing MDR.
- Overhead installation

The Mid-train, which includes the biological purification step and a buffer pool, is characterised by the following elements (WBL, 2012, p. 18-19):

- The ratio of biological and mechanical treatment is flexible;
- Techniques that have been considered for implementation using MDR are Ulbas-UCT, Nereda and MBR;
- Multi-use tanks: Instead of a single tank with compartments of fixed dimensions, customisable separate tanks for individual functions are advocated. These separate tanks can be designed using more durable materials, because the dimensions of the tanks are smaller than those of the combined tanks.
- Flexible tank size: The tanks are made modular by the use of segments. For the building materials that could be used to build these segments, concrete, steel, stainless steel, wood, etc. have been considered. The tank segments that have a long lifetime (> 40 years) have been proposed to be reusable for tank construction in other locations or for a tank with other dimensions in the same location
- Flexible buffer pool (for processing first flush);
- Overhead installation.

And finally, the End-train, which includes components with downstream techniques of effluent processing, is characterised by the following elements (WBL, 2012, p. 18):

- Linking of modules for the delivery of various types of water, together with a gutter;
- Transportable modules;
- Modules on the principle Plug and Play;
- Overhead installation.

The objective of this report is primarily to showcase the process of conceptualisation of MDR rather than evaluating the potential of this innovation. Therefore, we will not delve into a detailed analysis of the design specifications, the financial considerations and the business case as illustrated by the WBL report (WBL, 2012, p. 19-34). Hence, after providing a brief overview of the concept and its design components, we will now document the process of its development.

Note: The original WBL report (WBL, 2012) is in Dutch and this report offers free translations of the content of that report in English. The page numbers at which the original content is written in the WBL report have been indicated in every reference to the report.

Conceptualisation of MDR

The process of the development of MDR can be divided into two separate brainstorming sessions:

- Brainstorming sessions at Spa, Belgium organized in the month of November, 2011
- Sessions aimed at concretisation of the design of the MDR plant at the WBL office in Roermond, starting from February, 2012 up till its final presentation to the Management Team on 30th April, 2012.

There were other spaces such as Pastorie in Roermond

where a few sessions were held in January, 2012 and the concept was further discussed after Spa. But the team members indicated that substantial work on the conceptualisation of MDR was done during these two sessions and hence, the focus of our analysis will be on these two sessions.

The MDR project team composition shows that members had different levels of engagement with the overarching scope of work that MDR entailed before they started working on the concept together:

- There were members who had been thinking along the lines of sustainability in building and maintaining WWTP before the sessions at Spa were organised. Ad de Man mentioned in his interview that 'Guus had a few ideas in this direction and Olaf talked to us several times… Do you have ideas about that? I made some suggestions about what is possible and we all were making drawings about design of WWTP and the kinds of affluent water that we can create. [...] I worked with Olaf and we made an appointment with another Water Board at Delfland. Then we realized that when we focus on sustainability, on different affluent qualities, new nutrient recovery… We also had a kind of, let's say, knowledge development' (Interview, 06/06/2012). Ultimately, as the session at Spa began, only two of the members of the team (Olaf and Ad) which had initial discussions with Delfland Water Board were invited to these sessions.

- There were members, such as Jan Janssen, who had a separate meeting with the director of WBL on what the sessions at Spa were going to be about. Janssen indicated that he was given a general idea of what the discussions were going to be about (Interview with Jan Janssen, 12/06/2012).

- Others indicated that there was very little pre-information about what was to be done at the sessions. As Andries Vonken said in his interview, 'We were told that Guus has a few ideas about construction of a new Waste Water Treatment Plant and I knew that it had something to do with our focus on green eco-friendly Waste Water Treatment Plant. But, there was nothing specific that was discussed beforehand. We were told that there would be a kick-off meeting and we had to prepare something for it' (Interview, 14/06/2012).

- Finally, John Belleflamme was initially not a part of the MDR project team and he was invited towards the end of the Spa session for an evaluation of expected costs in designing an MDR (Interview with John Belleflamme, 14/06/2012).

Sessions at Spa, Belgium

The general structure of the meetings that were organised at Spa could be divided into two broad categories. The first were meetings that involved the presence of other people apart from the MDR project team, such as the initial kick-off meeting on the first day which had members of the Management Team, and evaluation meetings that were held at the end of the day which also involved Management Team members and workshops with external experts such as the one organised on different kinds of building materials for WWTPs. The second were brainstorming sessions within the MDR team members facilitated by an external co-ordinator. These sessions spanned for a period of two-three hours in one sitting. Since the members were living in the same place, they extended into the night even after dinner. Remembering these interactions, Janssen said that, 'The best ideas come after lunch and after dinner' (Interview, 12/06/2012).

The session at Spa began with an introductory session presided over by the director who laid out the foundation of what the concept of MDR should focus on. He offered a preliminary set of broad themes along which he expected the MDR project team members to brainstorm. These themes were as follows:

- Modularity
- Plug and Play
- Flexibility
- Work Culture of MDR plants

Jan Janssen believed that among these themes, 'flexibility was the most important theme for us' (Interview, 12/06/2012).

This introduction was followed by five-minute presentations by each member of the MDR Team about the initial set of ideas that they have about modular building of WWTPs. Each member made a different presentation; one of them highlighted the modular construction of big cranes at construction sites and another one showcased how a component of the WWTP that can be made in a modular way. Ad de Man just highlighted the reaction that engineers get when they come up with something new. He argued that the response that engineers get about implementing their ideas is always, 'Tomorrow' (Interview, 06/06/2012). Jan presented a photograph of a modular electrical cabin which is used in a traditional WWTP. The cabin is usually placed vertically with individual plug and play modules that can be replaced quickly. 'Just for a brainstorm, I felt that if we look at this cabin horizontally, we will have a representation of modularity that we would like from MDR. My intention was not to show that a WWTP can be built this way, I was just trying to change the way people thought about things without taking them for granted' (Interview with Jan Janssen, 12/06/2012).

The session progressed within the multiplicity of ideas that the team members had around the design philosophy of building MDR and was then streamlined into a set of questions that the week of sessions at Spa should answer:

- 'What is the framework and it's components for MDR?
- What kind of building materials do you use?
- Where can it be placed in Limburg?' (Interview with Ad de Man, 06/06/2012)

This marks the beginning of the second category of sessions organised at Spa. In order to answer the first question, a mind map of the individual components that make up a traditional WWTP was created on the first day itself. 'We broke down the complete process of making WWTP. And then, we started with the Front-train [followed by] biological treatment using Nerada [and] chemical treatment... We didn't consider energy. [The main question was how] can we transform the traditional WWTP into a MDR?

- For Front-train, it was the container idea [components such as filters, sand-traps etc. should be constructed such that they could be fitted into ship containers].
- Then we started thinking about biological treatments and the design of tanks. Tanks were made into segments.
- With this list [established by the mind map], we started to transform aspects of WWTP into the MDR concept and with [the size of the WWTP being] 20,000 p.e. [Population Equivalent (p.e.) is the number expressing the ratio of the sum of the pollution load produced during 24 hours by industrial facilities and services to the individual pollution load in household sewage produced by one person in the same time] it was a lot easier' (Interview with Jan Janssen, 12/06/2012).

Innovations with respect to the second question could not be discussed at great length. A workshop was organized in this regard with an expert on building materials. Ad de Man observed that this workshop was 'very difficult for us. When the speaker went away, I asked the group if they understood what he was saying. [The response was] 'No' or 'Yes, little bit'. So we decided to mail him saying, 'Thank you for a nice presentation but now we have a problem. We have to build this kind of thick tanks... what do you advice? What building material should we use?' And he could not answer that question' (Interview, 06/06/2012). Jan Janssen qualified the answer that he gave by mentioning that, 'He told us that I only know that it shouldn't be concrete' (Interview, 12/06/2012). In this respect, Andries Vonken highlighted a prospect for the future of discus-

sions on green-thinking and MDR, 'With respect to green thinking, well [MDR] uses energy and is built from steel and concrete so, I think it needs some more attention in that respect' (Interview, 14/06/2012).

With respect to the third question, Ad De Man said that, 'we took a map of our province and all the sewer systems. The first thing we thought about was what will be size of this treatment plant. Is there [a] minimum size? [Ultimately, we concluded that] we could build 50 MDRs. The capacity doesn't necessarily have to be big, it can also be small' (Interview, 06/06/2012). With respect to the size of the MDR plant, Jan Janssen explained that, 'Every day one of the Management Team members came over. And we made presentations [to them]. They asked why 20,000 p.e. and we said that it was just a mindset. Generally WWTP handle somewhere around 60,000 to 70,000 p.e. of wastewater. We chose a smaller capacity because it made the design easier and to get some results' (Interview, 12/06/2012).

With this brief outline of the organisation of the sessions at Spa, we will move onto the next set of sessions at WBL. More detail with respect to these sessions will be illustrated in the facilitating and hindering factors for the brainstorming sessions. To conclude, these sessions were primarily focussed on concretising concepts rather than the actual design of the MDR plant. For example, Jan Janssen mentioned that, 'In the original designs, the Front-train was very different and rest was the same. We made the Front-train only in blocks. It wasn't as far designed as it is now. We didn't detail out the blocks in Spa. Already the thought of containers was there but not exactly how it should be designed' (Interview, 12/06/2012). The same can be inferred with respect to the cost estimation of building MDR. John Belleflamme indicated that he was not very certain if the costs would be low because there wasn't enough time to do detailed calculations (Interview, 14/06/2012). In this respect, Olaf Durlinger clarified that, 'It was a kind of a guess. But, not a wild guess. We really tried to estimate how much time it would take to build installations above the ground. Well I said… what do we think about these goals set by Guus. Do we think that the yearly cost will reduce? Yes. Can we make the construction modular? Yes. And this is how we felt. We were not sure about it then' (Interview, 04/06/2012).

Sessions aimed at concretisation of the design of an MDR plant at the WBL office in Roermond

> 'At first, I thought it should be a concept. But, Guus asked a question, 'what do you see when you walk through an MDR?' And I thought, this is a very different question' (Interview with Jan Janssen, 12/06/2012).

The results of the brainstorming sessions at Spa were presented to the Management Team in December. As the quote by Jan suggests, a decision was ultimately taken to think about the complete design specifications of MDR and evaluate the costs of its operations. There were a few sessions that were organised in Pastorie, Roermond in this direction, but they didn't work very well. As Andries Vonken explained, 'You are far from home; you don't have the utilities you need; you don't have all the information because I have my books... I have all the stuff here. [...] So, I think I was the one in Pastorie who asked why can't we do this in a separate floor in WBL. It takes discipline to keep your daily work separate from MDR. But it can be done' (Interview, 14/06/2012).

Finally an initial plan of completing the design specifications of the MDR plant within 15 days was approved by the Management Team. 'But, it turned out to be 50 days' (Interview with Andries Vonken, 14/06/2012). The work began with creation of an excel sheet that was progressively filled out as the concept was further detailed. The team filled out initial placeholders for goals that were important to the design of the MDR and then, the document became the reference point for everyone. 'So that everyone is clear about priorities and the demands on the design. This document was the first action during the sessions. It was particularly difficult because we have to set our goals for the smart specifi-

cations of MDR, but we didn't know if we could reach it. But, ultimately we have reached most of the goals' (Interview with Jan Janssen, 14/06/2012).

These goals, borrowed from an internal project document (MDR Project Team, 2012), were in relation to the following initial placeholders (*the order does not indicate priority*):

- Quality of the affluent
- Capacity of the plant
- Corporate Social Responsibility
- Cost of operation
- Modularity in the context of standardization in terms of operation, maintenance, design and documentation and construction of parts that will be Plug and Play
- Modularity in the context of flexibility in terms of transportability of individual parts, 80/20 rule [at least 80% of the constituent components of a MDR plant should be made out of existing wastewater treatment technology, the rest 20% could be modified versions of the basic technology], ease of customisation and scale expansion.
- Construction of an MDR plant in terms of building material, construction time, rapid assembly on site, etc.
- The amount of space that an MDR plant would take.
- Sustainability assessments in terms of construction, reuse of building material, energy consumption, CO_2 footprint, other environmental factors and work culture around maintenance of the plant.

'The goals were selected from the initial characteristics of MDR defined by Guus. In the next meeting, we talked about the simplicity of operating MDR. It should not require some special expertise' (Interview with Jan Janssen, 14/06/2012).

The team members detailed out the flow of the interactions during these sessions by explaining that the division of work was based on the expertise of individual team members. As Olaf Durlinger pointed out, 'If a specialist is really a specialist, he must know everything about his field and should be willing to answer stupid questions. So we defined roles for everyone based on their expertise' (Interview, 04/06/2012). Focusing on individual expertise, Andries Vonken explained the division of work by stating that 'Ad and I had to make the design specifications of an MDR, and then Jan and Roger do the selection of the equipment that would match the design. John can make his [cost] calculations [based on the equipments]. Jan and Roger can make the energy calculations [based on the design and the equipments] and Frank did the analysis of maintainability [of the MDR plant]. So, everything had to follow each other' (Interview, 14/06/2012). Olaf Durlinger's role was primarily that of a Project Leader and he interfaced between the Management Team and the Project Team (Interview with Olaf Durlinger, 04/06/2012).

Vonken highlighted that the problem with such tightly-coupled division of work was that once the design specification of the MDR plant were drafted, they couldn't be changed 'because if we change it everything had to be done again' (Interview, 14/06/2012). Consequently the process of designing MDR became an iterative process. 'There were different scenarios for which we had to make separate calculations. [There were] 12-15 scenarios for conventional systems, then [for each system, there were] two to three different temperatures [at which wastewater could be treated] and two to three different affluent qualities. Ultimately, I think we did 100 different kinds of calculations for different scenarios' (Interview, 14/06/2012). A remark by Ad De Man further explicates this iterative process, 'Technologists like me were focused on the idea that wastewater treatment plant should look like this and then, the cost is evaluated and then, mistakes were pointed out in implementation and then, we started to re-design' (Interview, 06/06/2012).

As the project progressed, some ideas became more and more concrete. Ad de Man specified that the design of the Front-train and the Mid-train were formalised by the end of February, 2012 (Interview, 06/06/2012). In this regard, Olaf highlighted that, 'Jan was the guy who actually invented the Front-train' (Interview, 04/06/2012). When asked about the thinking behind the idea of the Front-train, Jan remembered that, 'Front-train idea was quite simple in fact. We were thinking about sand-traps and which ones should be used because traditional sand-traps are very large. And I was fixed on the design of sand-trap. [Sand trap is a structure that is constructed to exclude the quantity of sand that is carried by water flowing in a channel or tunnel]. And I realized that if every component could be fixed with connections to the main water channel, then we have modularity. That's all! So when this idea came up, we started to figure out how individual components of the Front-train would be attached to the guiding rail and everything happened quickly' (Interview, 12/06/2012). With respect to Mid-train, Ad de Man and Andries Voken were in-charge of the design. For Mid-train 'the conversation was about should we build a single tank or several tanks and what are the consequences in terms of cost if you build it in several tanks' (Interview with Ad de Man, 06/06/2012).

The major focus of these sessions was the cost of building and maintaining an MDR plant. Ultimately the consequences of this focus were summarized by Ad de Man when he mentioned that, 'One thing is very important… we focused on the costs. We realized that the Front-train can be made very modular and it will not have a very big negative influence on the costs. But, we realized that if we make more tanks, it will be more expensive. The [current] cost has been calculated on the basis that the Mid-train is not very modular. It can be made more modular on the same costs but that's one thing that we haven't looked into at the moment' (Interview, 06/06/2012). In this respect, the final cost calculations has also been reviewed by external experts and they reported back to the Project Team that, 'You [have] calculated conservatively. There are more Euros to be gained. There is more in it' (Interview with Andries Vonken, 14/06/2012).

This focus was later translated into the development of a business case for the MDR plant upon the insistence of the Management team as Jan Janssen mentioned, 'Guus wanted to know if it was cheaper' (Interview, 12/06/2012). All the members of the Project Team unanimously agree that Carla Koen was very helpful in the development of the business case. In this respect, two comments made by Jan Janssen and Ad de Man are important:

- On her role: 'We had to reach this 20% [reduction in costs]. And that is where Carla helped us. She said that is the focus. She knows how to sell an idea… some things that are important to design may not be necessary to be written in the report. That's a way of thinking we don't have. We are very technical people and we solve problems by applying technology' (Interview with Ad de Man, 06/06/2012).

- Her approach towards the team: 'Carla came in and said, 'You have a lot of ideas in your mind, but it isn't on paper. Put everything on paper. Every thought you have from now on, you should put it on paper'' (Interview with Jan Janssen, 12/06/2012).

As these sessions reached towards the deadline of the final presentation to the Management Team in April, the individual concepts around construction and maintenance of MDR became concrete design specifications and the cost analysis was transformed into a concrete business case. With respect to the development of the business case, Andries Vonken observed that, 'Business plan came in more at the end. We had a presentation with a short film in the mean time. [It was decided that] she will write the format and we will provide the content for the report. She was here for a few times but I didn't have any meetings with her. It was only Olaf, Ad and Jan. The main senior members of the working group had the discussions' (Interview,

14/06/2012). Finally the business case and the entire MDR concept were presented to the Management Team on the 30th of April, 2012.

As we end this section on the general outline of the sessions organised at Spa and WBL and move onto the facilitating and hindering factors that had an impact on the organisation of these session, the question of alternatives to the present conceptualisation of MDR that were thought of while designing the plant but were later discarded still remains. In this context, Ad de Man answered that, 'I don't think we have an alternative at the moment. I think it was more like Roger and Jan had some ideas and we thought about how to make them work and how to build a wastewater treatment plant based on these ideas was the prime concern. [...]Now the idea that we have is one end-product. We don't have another alternative' (Interview, 06/06/2012). All the Project Team members mentioned that they were very satisfied with the development of this end-product and they felt challenged and creative at the same time. They also mentioned that these sessions were very intense and they learnt a lot more than they had expected. In terms of an organisational culture of innovation, MDR represents a successful culmination of Idea-Conversion phase. In the concluding sub-section of this part of this report, we will also look into how does the process of conceptualising MDR figure in the Innovation Value Chain.

Hindering Factors

Among hindering factors, the following require critical attention:

- **External Facilitator for Spa Sessions**: The Project Team Members had a mixed response to the external facilitator for the Spa Sessions. As Jan Janssen elaborated, 'There was a facilitator to structure the discussion, but he didn't quite fit into the group. He mixed too much in the discussions. [...] I don't know if it was positive or negative. I wasn't very bothered but Ad and Olaf weren't very pleased with his presence. I guess the only thing that I would change is that the facilitator should leave at the end of the discussion sessions, at the end of the day and doesn't stay with the group. I guess it is difficult if you're the only outsider and the rest of the group knows each other really well.' (Interview, 12/06/2012).

- **Lack of pre-information about the sessions for some Project Team Members:** Some members of the MDR Project Team had little information about the nature of the brainstorming sessions being organised at Spa. Andries Vonken mentioned that he could only 'Google modular sustainable waste water treatment plant and then, see what's out there' (Interview, 14/06/2012) as background research for these sessions. John Belleflamme, on the other hand, was just invited to the sessions without any information one day before the end of the Spa sessions (Interview, 14/06/2012). This lack of background preparation can affect how an individual might approach a completely new way of thinking that is required for such brainstorming sessions in the absence of their familiarity with it. Though, Vonken and Belleflamme did not mention this aspect of their involvement as an explicit problem, it is imperative to keep a balance in the pre-existing knowledge of individual team members before they start their discussion on a new idea.

- **Lack of knowledge on the implications of building materials:** Ad de Man highlighted this problem as we have already mentioned in the general outline of the Spa sessions. This lack of expertise on the implications of building material has also influenced the final outcome of the MDR conceptualisation wherein the tanks in the Mid-train have been designed to be built out of 'steel and concrete' (Interview with Andries Vonken, 14/06/2012), which seems to be the building material that the Project Team was most familiar with. Vonken also went on to say that, 'Wood [as a building material...] didn't work very well with the Project Team' (Ibid.).

- **Division of the Project Team into two rooms for WBL sessions:** While at Spa the team could work in a single space, Jan Jassen indicated that at WBL, 'Unfortunately we couldn't get one room for all the members. That was a pity. Because Andries and Frank were not in the same room. That should be different the next time. Everyone should be in the same room, so that everyone gets the same information' (Interview, 12/06/2012). This aspect of being able to share information is important for working on new ideas. Since the project also involved such tightly-coupled division of work, being in the same room, will facilitate decision-making with faster resolution of problems faced by individual team members.

- **Lack of clarity on the expectations of the Management Team from the detailed design specifications of MDR:** Ad de Man provided insights into this factor as he discussed management of expectations from the project. When asked whether he would like to change some aspect of the organisation of projects on new ideas for the future, he pointed out that, 'It would be the communication with the Management. That is something that is not easy. Meeting their expectations was difficult and we had several contact moments; they were not so nice. Olaf had a double role. He was a part of our team and he was a part of the management team and for him it was not so easy. There was a moment that I experienced with Olaf where I realized that it was difficult for him to have a good communication and I asked him, 'What are the expectations from the end-product?' I think it is impossible to tell in half an hour what we did in all these days. That's why one day we made some kind of presentation saying these are the things that we have worked out. That was an important moment where everybody was satisfied. So I think management of expectations is important' (Interview, 06/06/2012).

- **Secrecy on the nature of the MDR project within WBL:** All members of the Project Team who were interviewed unanimously agreed that in-house communication on the MDR project should have been better and the secrecy around their work was not entirely necessary. Olaf Durlinger pointed out that, 'It's very strange that you work with all your colleagues and from one point in your life you have to tell them… 'I can't tell you about what I am doing.' That can be very strange because that's not how colleagues should co-operate and I know that some of the team members found that very difficult' (Interview, 04/06/2012). Ad de Man further elaborated this problem by saying that, 'We used to sit in different place and in our conversations we would ask our colleagues questions without giving them an idea as to where they were coming from. [...] In this team, it's a nice team but it doesn't have 100% of knowledge of course. We should be more open' (Interview, 06/06/2012). On the necessity of secrecy, Andries Vonken expounded that, 'Well with respect to the point of keeping it secret, for me, it wasn't that new. I didn't necessarily see the need to keeping it secret, but we had to and we did, but it wasn't that secret actually' (Interview, 14/06/2012).

  Ad de Man further elaborated on the implications of this secrecy, 'The connection that you feel to a product that you have worked on is far better than the connection that you make by watching a film about the product. How to make this connection better in the future is very important. Don't think that you show a film and everybody is connected to the project. [...] I think at the moment [this connection] is limited to a very few people' (Interview, 06/06/2012). Jan Janssen had a solution this problem; he explained that, 'We can do it through intranet. There was only one short notice after Spa that we were busy with MDR and its secret and that was the last. We should put [more information] on the intranet, so that the importance of the development is clear to everyone' (Interview, 12/06/2012).

- **Time Management between daily work of WBL**

and working on MDR: Jan Janssen discussed this issue at length. His opinion on time management of his work was that, 'If I want to do this job right, then I can't do anything else. [The Management] asked if my work can be turned over to someone else and I said that they will come back to me if they have any questions. And that doesn't work for me; neither will it work for them' (Interview, 12/06/2012). He further elaborated that everybody had a different approach to time management. Some team member such as Ad de Man did continue working on the other projects which were a part of their daily work, but he did not feel that he would be able to multi-task between MDR and other projects. He further explored the way MDR sessions were organised by stating that, 'It works for the idea that you're working on but it doesn't work for my colleagues. Well as I explained my role in WBL, my colleagues wanted advice and support on other projects. And I couldn't provide them the support that they needed. If you say that get an idea and get it done. This is the right way. But, you must take into account what the impact is on the organization and the rest of the work and other projects' (Ibid.).

- **Appropriation of the MDR concept within the work culture of WBL:** Ad de Man highlighted this problem when he mentioned that, 'Up till now we have only shown the idea to the Management Team and now the implementation of projects has been stopped. To change all of a sudden… that's not nice. It must be clear for the whole organization, which projects are influenced by MDR and which are not at all' (Interview, 06/06/2012). In this sense, clarity in terms of prioritisation of the MDR concept requires further attention.

Facilitating Factors

Among facilitating factors, the following could be considered as especially important:

- **Support offered by the Management Team:** One of the most important factors that have led to the finalisation of the MDR concept has been the constant support and interest of the Management Team. The brainstorming sessions were initiated by the Director of WBL, at least one of the Management Team members was present on everyday at Spa, there were multiple instances of contact between the Management Team and the Project Team during the time span of the project, the Management Team also supported the time extension of the detailed design specification meetings at WBL from the original 15 days to the final 50 days and finally they also supported the decision of Team Members such as Jan Janssen to only focus on MDR while the project was going on. This aspect of the project was showcased by Andries Vonken, 'To be able to move beyond the tunnel vision and look outside and see what's there. Here the credit goes to the management team. They for example had [organised] the innovation sessions. We were made aware of techniques by which we could research what are the currently available technologies. They are promoting fresh and innovative ways of looking through problems' (Interview, 14/06/2012).

- **Initial Placement of the team outside the WBL environment**: All of the Project Team members who were interviewed agreed that the organisation of the first set of sessions in Spa was useful. As Andries Vonken highlights, 'This way of doing projects… not having 20 meetings of one hour but one meeting of 20 hours [...] is a more effective way of getting things done' (Interview, 14/06/2012). He further explained in connection to sessions organised at Spa that, 'the idea [of MDR] and being together, in another place with another mindset, it was good. But that also could be done 15 kms from here. You have to be outside this office for that session, but if it had to be Spa. That was not necessary for me' (Ibid.). The place in and of itself may not be consequence to the Project Team Members, but all

of them agreed that initial conversations on MDR required being outside the work environment of WBL to facilitate a change in mindset.

- **Getting a sense of how different team members think about modularity before the sessions began**: Ad de Man showcased this point as a facilitating factor for the conversations, when he explained that, '[The sessions were] very well organized and to first have everybody have a say as to what they think about modular way of building [was also useful]. Because I think Frank's idea of cranes was also used in the presentation made to Guus. If you don't start with this, everybody goes on working their own way and you don't get a sense of how they would like to approach the problem' (Interview, 06/06/2012). This factor becomes especially important when the team members belong to different departments within an organisation. Their way of thinking is usually influenced by the nature of their work. To get a preliminary sense of how everybody would like to approach the problem facilitates a shared understanding of expectations that everybody has from the project and how they would like to approach problems at hand.

- **Longer engagement of some Project Team members with sustainability issues around the construction of WWTP:** The longer engagement of a few members with sustainability issues enabled a faster rationalisation of the operational understanding of sustainability issues with respect to design and construction of WWTPs. As Ad de Man said, 'My role was to realize the rough ideas that we had [from previous engagement with sustainability issues] in a very practical way' (Interview, 06/06/2012). As we have already highlighted in the *BESSE Pilot Study WP6* (BESSE, 2011), there is a vast difference in the way sustainability issues are thought about across WBL. Having team members that have engaged with the issue for a longer period enables an addition of experience with sustainability to the Project Team. This experience has certainly helped in the long run, as Ad de Man puts it, 'MDR is not based on old knowledge but on contemporary innovations in the field of sanitation' (Ibid.).

- **Multi-disciplinarity of the MDR Project Team:** The composition of the MDR Team, as showcased in Table 1, also points to the difference in expertise that every team member brought to the brainstorming sessions. It not only enabled an interaction with respect to every aspect of the design and construction of a WWTP, it also facilitated the tight-coupling of the division of work as the activities of individual members followed one another. Without this multiplicity of varied backgrounds, the MDR conceptualisation would have required a lot more help from external experts and time than it ultimately did.

- **Ability to think beyond the traditional ways of constructing WWTPs:** This ability has been the focus of attention for MDR right from the beginning. WBL's primary function is to build WWTP based on the technologies provided by their suppliers. One of the primary questions of WBL employees that had to be answered before thinking about new ways of constructing WWTP was 'whether it is our task or is it our duty to come up with something new. And Guus replied that well if one of the products of this discussion is that we will be able to build cheaper plants then it is in everyone's interest. So, he said that this is our work' (Interview with Olaf Durlinger, 04/06/2012). In this respect, Jan Janssen pointed out that one of the major considerations for him while working on the MDR concept was to be able to change the way of thinking that goes into the construction of a traditional WWTP. This ability to think has been instrumental in the conceptualisation of MDR and has ultimately led to development of a Front-train design for which WBL has filed a patent application. The support that the other team members gave to Jan as illustrated by Ad de Man when he said that, 'Roger and Jan had some ideas

and we thought about how to make them work' (Interview, 06/06/2012) has been a facilitating factor that enabled the entire MDR concept to go beyond the traditional way of constructing WWTP.

- **Ability to incorporate existing technological solutions into the construction of an MDR plant:** Innovation with respect to MDR lies in its ability to combine pre-existing technologies into a new design of a WWTP. The focus was on standardization rather than creation of a completely new design which required innovative technologies. As Ad de Man expounded, 'Currently, we define the requirements of every plant before building it but with MDR we have a set of standards as to how much wastewater can be processed by one MDR unit, if the requirements exceed what can be processed by one unit. We can make an installation with two units of MDR. The other thing is that if a certain part of the WWTP stops working, it can be easily replaced. So, it is easier with MDR to change or expand the capacity of a WWTP' (Interview, 06/06/2012). An explicit focus on the 80/20 rule (MDR Project Team, 2012) as an initial placeholder for goals enabled the team to think more in terms of innovative ways of using existing technological solutions rather than designing new solutions which would have required more time and effort on part of the Project Team.

- **Presence of an external expert for creating the Business Case:** Our general outline of the sessions organised at WBL already showcases this point in terms of the role Carla Koen played and her approach to the process of writing the Business Case. Koen seems to have acted as a bridge between the expectations of the Management Team and the work done by the Project Team. She has facilitated in overcoming the hindering factor of *Lack of clarity on the expectations of the Management Team* by acting as a translator. As Ad de Man clarified, 'We are very very technical people focused on details. And when [Carla] came in, she said, 'Not too many details'. You spend a lot of time in detailing and you win almost nothing because when you give a lot of details, [new] questions come up. That was the balance between quality and time and she helped us as well as the Management team [...] because I don't think we would have had this result without her input' (Interview, 06/06/2012).

Placing MDR in the Innovation Value Chain

We have already illustrated the Innovation Value Chain in *Section 2.2 and Section 2.3* of this report, hence in this section we will directly look into how the lessons learnt from BESSE and the heuristics of the Innovation value chain have been operationalised with respect to the MDR concept. Table 5 places the organisation of MDR within these heuristics and provides insights into the focus areas for the future to enable a culture of in-

Table 29: Operational analysis of MDR within the Innovation Value Chain

Generally Applicable Lessons Learnt	Operationalisation for MDR
Systemacity	The process for the detailed design specifications of MDR was made systematic by specifying the initial placeholders for goals of the project in an internal document (MDR Project Team, 2012).
Integration	The integration of the MDR concept, within the organisation as well as in its network of stakeholders, is still a challenge that WBL is tackling with. We have already shown *Secrecy on the nature of the MDR project within WBL* as a hindering factor. For the outside network, a quote by Jan Janssen can be used to succinctly describe the situation. For traditional WWTPs, 'it is the technology suppliers that do the detailing work. So, we are not sure whether we are getting the detail that we want in MDR. It's important for MDR that the connections are standardized. The components should be standardized. And it's not the way we work now' (Interview, 12/06/2012).
Adaptation of scale	To handle the problem of Integration highlighted above, WBL will have to come up with a communication plan that can be adapted to the different scales at which the MDR concept needs to be communicated.

Phase	Constituent components	Lessons Learnt	Operationalisation for MDR
Idea Generation	In-house idea generation	Reflexivity	The Director of WBL's assertion that, 'if one of the products of this discussion [on MDR] is that we will be able to build cheaper plants then it is in everyone's interest' (Interview with Olaf Durlinger, 04/06/2012) and his invitation to external expert on building materials for a workshop with the Project Team can be seen as an example of this lesson in practice. But, we cannot generalise the presence of this lesson in practise for the entire organisation of WBL using this case study.
		Exploiting the local dimension	——
	Cross-pollination among departments	Plurality of knowledge	We have illustrated this lesson in practise by showcasing *Multi-disciplinarity of the MDR Project Team* as a facilitating factor.
		Participatory Approach	Ad de Man comment on the implications of *Secrecy on the nature of the MDR project within WBL* provides insights into the way forward for WBL in the context of this lesson. 'The connection that you feel to a product that you have worked on is far better than the connection that you make by watching a film about the product. How to make this connection better in the future is very important' (Interview, 06/06/2012).
		Exploiting the local dimension	This lesson has been completely practiced in the context of MDR as all the team members of the Project Team were WBL employees.
	External sourcing of ideas	Convergence of supply and demand	The MDR Project Team members do not show any signs of 'not-invented-here' attitude. During the sessions, there are significant pointers to the team members engaging in continuous research on the internet and interacting to external experts for concretising their ideas.

Idea Conversion	**Selection**	**Preliminary analysis of knowledge needs**	—
		Transparency	
		Monitoring	In this context, we have highlighted the interest that the Management Team has shown in the MDR project in *Support offered by the Management Team* as a facilitating factor. The project was constantly monitored with Olaf Durlinger acting as the interface between the Management Team and the Project Team.
	Development	Iterative interaction	This lesson in practice can be seen in the tightly-coupled division of work for development of design specifications of MDR.
		Flexibility	Ad de Man highlighted the process of trial and error that this lesson incorporates by mentioning that, 'Technologists like me were focused on the idea that wastewater treatment plant should look like this and then, the cost is evaluated and then, mistakes were pointed out in implementation and then, we started to redesign' (Interview, 06/06/2012).
Idea Diffusion	Spread	Brokerage case studies	Application of this lesson will be very useful for the development and design of the communication plan on MDR.
		Brokerage survey	**Application of this lesson will be very useful for the development and design of the communication plan on MDR.**
		Visibility of the benefits of new knowledge	In the context of this lesson, most of the doubts and scepticism around whether MDR will work can only be completely clarified with the implementation of the concept with a prototype. Andries Vonken specifically highlights this aspect, 'My [...] concern is how people from other water boards will react. The idea needs to be appropriated. It can be easily copied as well. So the big discussion now is how we are going to develop this, put it on the market and make sure it has a good swing so that we really have the first MDR. Will it succeed?' (Interview, 14/06/2012). Limiting MDR just to the domain of conceptualisation will have a negative impact on enabling the culture of innovation within WBL.
		Transparency	Transparency should be considered as an important aspect of the communication plan for MDR.

To conclude, this section was dedicated to the analysis of the conceptualisation of MDR as a case study of successful innovation within WBL. We have illustrated how MDR follows most of the lessons learnt from BESSE and the heuristics of the Innovation Value Chain. In this sense, we have not only showcased MDR as a successful instance of the application of the Innovation Value Chain that requires critical attention with respect to the *Idea Diffusion* phase, we have also shown how the theory behind enabling the culture of innovation within any firm operates and can be very useful if applied systematically by any organisation. In the next section, we will conclude this report by analysis the policy guidelines recommended by the *Position Paper* (BESSE, 2012a) and how can they be contextualised for implementation within WBL.

The Future of Knowledge Brokerage and Innovation in WBL

This section is intended to place the policy guidelines specified by the *Position Paper* (BESSE, 2012a) in the context of the conceptualisation of MDR and enabling innovation within WBL. In this respect, our approach is going to be a systematic listing of the policy guidelines and their placement into different categories based on our analysis of the MDR case study. The different categories that we shall use are as follows:

- Policy Guidelines that seem to have been intuitively appropriated by WBL
- Policy Guidelines that need critical attention

- Policy Guidelines that cannot be associated with the MDR case study but are nevertheless, important for consideration for WBL

Intuitively Appropriated Policy Guidelines

In this context, the following policy guidelines as illustrated by the *Position Paper* (BESSE, 2012a) can be listed:

- R1. Putting knowledge transfer on the sanitation innovation policy agenda (BESSE, 2012a, p. 31).
- R7. Promoting cooperation among disciplines and among different research areas connected to ESS [Environmentally Sustainable Sanitation] (BESSE, 2012a, p. 34-35).
- R8. Supporting the establishment and spread of new ESS-driven criteria for evaluating research programmes] (BESSE, 2012a, p. 35).
- R9. Encouraging university-industry partnerships to accelerate the transition from research to technological development and patenting (BESSE, 2012a, p. 35-37). This aspect is particularly visible in interactions of WBL employees with TiasNimbas Business School and other university researchers.
- R11. Promoting a multidimensional view of innovation (BESSE, 2012a, p. 38).
- R12. Facilitating a mainstreaming of innovation and ESS within water & sanitation companies (BESSE, 2012a, p. 38).
- R13. Carrying out technology scouting (BESSE, 2012a, p. 38-39).
- R14. Dialogue with universities and research institutions (BESSE, 2012a, p. 39).

Policy Guidelines that Require Critical Attention

In this context, the following policy guidelines as illustrated by the *Position Paper* (BESSE, 2012a) can be considered important to the development of a communication plan for MDR:

- R2. Promoting knowledge brokerage as a tool to support ESS (BESSE, 2012a, p. 31-32).
- R3. Attracting knowledge brokerage practitioners to the field of sanitation (BESSE, 2012a, p. 32).
- R4. Producing and accumulating experiences on the integration of KB practitioners with sanitation players (BESSE, 2012a, p. 32-33).
- R6. Enhancing communication on ESS-related research and its results (BESSE, 2012a, p. 34).
- R10. Making the economic and environmental benefits of ESS visible within the organization and company networks (BESSE, 2012a, p. 37).

Beyond MDR, Policy Guidelines for WBL

In the general context of WBL apart from the MDR case study, the following policy guidelines require critical attention:

- R15. Taking stock of the knowledge already developed in the company (BESSE, 2012a, p. 39-40).
- R16. Fostering the development of local, national and international innovation networks in sanitation (BESSE, 2012a, p. 40-41).

The Future of Environmentally Sustainable Sanitation in WBL

> 'The extent to which [knowledge brokerage] can facilitate innovation is linked to its capacity to be a **catalyst** [emphasis in original] of social

APPENDIX I: TOPIC GUIDE FOR RESEARCH INTO THE DEVELOPMENT OF THE MDR CONCEPT

energies, actors, resources and ideas, fostering the achievement of concrete and widespread results in as short a time as possible. Precisely for this reason, knowledge brokerage has to become a practice that is commonly applied in all phases of innovation and shared by all actors involved in the innovation process' (BESSE, 2012a, p. 49).

The policy guidelines in the *Position Paper* (BESSE, 2012a) specifically address knowledge brokerage as a process and a phenomenon with respect to the varied stakeholders that need to work together in promoting environmentally sustainable sanitation (ESS). WBL is one such stakeholder in the larger network of the sanitation sector. While there are considerable issues and concerns with respect to sustainability thinking within WBL (BESSE, 2011), the overall prioritisation of sustainability in the mission strategy document of WBL can be seen as the first step towards promoting ESS. The placement of MDR concept fits in extremely well in this respect. As Olaf Durlinger showcased, 'As a joke, I tried to look at how much of our mission statement corresponds with the ideas of the MDR concept and as you can see, out of the 320 words that our mission statement has… 60-70% is in some way connected to MDR' (Interview, 04/06/2012). In this sense, the conceptualisation of MDR and its eventual implementation will be the way forward for WBL to promote its objective of ensuring ESS in Limburg to begin with, then The Netherlands and ultimately, the world. We believe that the focus now should be on orchestrating an elaborate knowledge brokerage process to facilitate appropriation of the MDR concept within as well as outside WBL in its network of stakeholders.

WBL and MDR:

- How would you define your role within WBL as an organization and subsequently, within the team that worked on conceptualizing the MDR model of wastewater treatment plant?
- How do you understand the MDR model? What are the key features and advantages of such a way of designing wastewater treatment plants?
- In designing an ideal wastewater plant, what would be the key features of the design of the plant that you would focus on?
- What are the current best practices of designing wastewater treatment plants and how is MDR different or similar to them?
    - ◊ How would you evaluate the MDR model along the key features of the design of an ideal wastewater treatment plant that you explained earlier?

Brainstorming session in Belgium:

- How were invited into the team of seven members who were involved in the ideation and conceptualization of the MDR concept?
- What were your expectations from the brainstorming session in Belgium?
- How was a typical session organized, what was the length of each sessions in terms of time, what material did you use during your discussions, for example, pen, paper, whiteboards etc.?
- If you were to summarize the interactions that happened during these brainstorming sessions, what aspects of the design of a wastewater treatment plant were discussed at length and why?
- Within each of the aspects that you highlighted in the previous question,

- ◊ Which one do you consider to be the most important for you?
- ◊ Secondly, which one do you consider to be the most important with respect to the subsequent development of the MDR concept later at WBL?

- What was the end result of these brainstorming sessions?
- Are you satisfied with these sessions and the way they were organized? Why? What changes would you recommend, if such sessions were to be organized again in the future?

WBL sessions on conceptualisation of MDR

- What difference did you notice in your sessions here at WBL as compared to the ones in Belgium?

◊ What were your expectations from the conceptualization sessions at WBL?

◊ How was a typical session organized, what was the length of each sessions in terms of time, what material did you use during your discussions, for example, pen, paper, whiteboards etc.?

- How did the conversations on an efficient wastewater treatment plant design change after you presented your work in Belgium to the Director of WBL? Which directions were emphasized and which of them were left out?
- Were there other models of building wastewater treatment plants that were discussed apart from MDR during the conceptualization phase? If yes, please briefly describe them and why do you think MDR was the best option among the models that you discussed? If no, what were the factors that made MDR the only option that was worth the attention of the team?
- Are you satisfied with these sessions and the way they were organized? Why? What changes would you recommend, if such sessions were to be organized again in the future?

Future of MDR and Sustainability within WBL

- What are the potential problems that you see in implementing the MDR concept? What aspects of the concept require further attention and development?
- Do you think that the application for a patent on a part of the MDR concept is valuable for WBL? How?
- Do you see MDR concept as a step towards stimulating 'Green Thinking' within WBL? According to you, where do these two ideas meet and how can they be useful to each other?
- Finally, did the MDR concept meet your initial expectations from the project? How would you summarize the lessons learnt from this exercise?

APPENDIX II: RATE YOUR COMPANY'S INNOVATION VALUE CHAIN

APPENDIX II

'If you want to improve your company's innovation performance, here is a good place to start. Have about 30 employees from a cross-section of functions within the company fill out this questionnaire. Calculate the average score for each activity, and focus your attention on the highest one or two numbers – these are your weakest links' (Hansen & Birkinshaw, 2007, p.129).

	Do not	Partially	Agree	Activity	Phase
Our culture makes it hard for people to put forward	1	2	3	In-house idea generation	High scores indicate that your company may be an **idea-poor company**.
People in our unit come up with very few good ideas on	1	2	3		
Few of our innovation projects involve team members	1	2	3	Cross-pollination among departments	
Our people typically don't collaborate on projects across	1	2	3		
Few good ideas for new products and businesses come	1	2	3	External sourcing of ideas	
Our people often exhibit a 'not invented here' attitude – ideas from outside aren't considered as valuable as those invented within.	1	2	3		
We have tough rules for investment in new projects – it's often too hard to get ideas funded.	1	2	3	Selection	High scores indicate that your company may be a **conversion-poor company**.
We have a risk-averse attitude toward investing in novel	1	2	3		
New-product-development projects often don't finish on	1	2	3	Development	
Managers have a hard time getting traction developing	1	2	3		
We're slow to roll out new products and businesses.	1	2	3	Diffusion	High scores indicate that your company may be a diffusion-poor company.
Competitors quickly copy our product introductions and often make pre-emptive launches in other countries.	1	2	3		
We don't penetrate all possible channels, customer groups, and regions with new products and services.	1	2	3		

BIBLIOGRAPHY AND END NOTES

End Notes

1. The Regional and Global Development Research Centre (REGLO) would like to express its appreciation for the successful and productive cooperation with Pernik Municipality and the Water Supply and Sanitation Company Ltd., Pernik in the course of the pilot project implementation.

2. Limburg is the most southern province in The Netherlands.

3. Peter Ulrich, Marble Paper, p. 55

4. MDR: '*modulaire duurzame rioolwater zuiverings installatie*' (Modular Sustainable Water Sanitation Plant). MDR is a new design concept for water treatment plants, in which green and flexible building techniques are combined with shorter depreciation periods to allow incorporation of newly emerging technological solutions.

5. See the annex for a list of interviews.

6. The quotes in this section are free translations from the original Dutch answers to the questionnaire.

7. Reference to section Summary of Lessons learnt: BESSE (2010). *Map of the hindering and facilitating factors to the transfer and dissemination of knowledge and technologies connected to environmentally sustainable sanitation.* Rome: LSC

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