Transactions of the Association of European Schools of Planning • 3 (2019)
doi: 10.24306/TrAESOP.2019.02.002

SYSTEMATIC SHARING OF KNOWLEDGE OBTAINED IN PILOT PROJECTS IN SPATIAL PLANNING

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(Received 15 September 2017; revised version received 22 August 2018; final version accepted 16 April 2019)

Abstract

Pilot projects are implemented to obtain results and knowledge that can be reused subsequently. In this paper, we address the question of the efficient and effective distribution of insights between pilot projects. We present detailed considerations on the structures which are required to share the results and knowledge obtained through evaluations of the stages of pilot projects. By establishing such structures, the reuse of existing knowledge is significantly simplified. A common structure for pilot projects allows for information sharing between equal stages of simultaneously running pilot projects. If the obtained knowledge of these individual stages is easily accessible, the need to review a comprehensive final project report is eliminated. For future pilot projects and large-scale projects, the costs associated with reusing existing knowledge is reduced and the cost-benefit ratio improves. We exemplify this by investigating systematic information sharing between equally structured pilot projects.

Keywords

Pilot projects, sharing of knowledge obtained in pilot projects, knowledge management, process management, project management

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1. Introduction

Spatial planning often has to deal with novel challenges where no experience or know-how pre-exists – either specific or general. In such scenarios, it is common scientific practice to create a model and test a hypothesis through it. Models reduce the complexity of reality and are simplified projections of the real systems or issues they help to understand. Simplification is characterised by illustration, reduction and pragmatism. If a developed model turns out to be too simplistic with respect to a specific aspect, it is usually refined. Afterwards, examination is repeated on the more elaborate model that, in turn, might reveal decisive weaknesses in a different aspect. Then, the process is repeated. After the model's accuracy is assessed positively and if obtained results are promising, real-world tests are conducted.

In spatial planning, however, this approach is usually destined to fail as the model cannot be refined to a level that allows for sufficient certainty. Spatial planning activities are always embedded in a socio-cultural environment. They involve many participants who are linked by complex structures. Neither the participants nor the structures can be captured appropriately in a simplifying model. Therefore, spatial planning implements pilot projects – small-scale, short-term real-world studies. They constitute the preferred instrument approach for novel challenges in spatial planning.

Pilot projects are an important research tool and an innovative working form in urban and regional planning in particular (van Buuren and Loorbach, 2009). For these planning activities, the objective is to obtain novel, individual (sub-) projects in a definite period of time that can be reproduced.

Pilot projects are a popular policy instrument, as they allow decision-makers and innovators to test new approaches under realistic conditions but with decreased or removed risk. Similar to several other areas, spatial planning faces various challenges which emerge from factors such as demographic change, climate change, globalisation, and digitalisation. Due to the novelty of these challenges, new approaches and solutions need to be developed in order to mitigate negative effects, to adapt to new circumstances, and to grasp opportunities that arise. The new approaches are elaborated and tested as well as being incrementally implemented in pilot projects. Pilot projects "are also popular with decision makers because they provide an elegant means of sliding out of a policy process" (Vreugdenhil, 2010, p.3).

Pilot projects are starting points for large-scale changes or policy innovations. Novel ideas can be implemented on a small scale as a preliminary practice. After a positive evaluation of the outputs, outcomes, and impacts, the novel ideas are often implemented in their entirety (van Buuren and Loorbach, 2009; Vreugdenhil, 2010). Additionally, pilot projects focus on innovations, enable the development of knowledge in policy impacts, encourage participation, and bring participants involved in the novel challenge together. In a collaborative learning process, the participants obtain innovative solutions for persistent problems in a specific area and gain experience in applying innovation and cooperating with other stakeholders. In this way, pilot projects contribute to overcoming existing yet insufficient patterns in spatial planning practice. Based on the encouragement of policy or societal discussions and changed behaviours, pilot projects allow to practice change and in this way to possibly change existing practices (van Buuren and Loorbach, 2009; Vreugdenhil, 2010).

Although pilot projects possess significant potential for developing new approaches to face novel challenges, their initiators, participants, and evaluators are often disappointed with the overall results obtained. In many cases, pilot projects continue to be a detached event that do not broadly implement the innovation as anticipated. Criticisms are that policy-makers are not open to learning, that funding for further studies is missing, that participants are going back to their usual business, and that numerous unresolved conflicts emerge during the term of pilot projects. Nevertheless, for some participants it could even be of interest to diffuse negative results or messages to help to exclude certain policy options. Reasons for this kind of diffusion are that the innovation could harm the participants' interests, or that relationships have worsened so much that a subsequent cooperation is no longer possible (Vreugdenhil, 2010).

Academic and/or private institutions scientifically monitor pilot (sub-) projects in order to identify generally valid results that highly qualify for reuse in other municipalities, regions or on a larger scale (Gilcher and Steinebach, 2018).

The importance of monitoring already indicates the significance of its result: project evaluations. In previous work, these evaluations were presented in final reports that focused on determining the following two aspects:

- Were the initial (sub-) project goals achieved?
- Are there results that can be reused on a larger scale?

However, our monitoring experience (Steinebach, Gilcher and Felz, 2018) revealed that this overall evaluation of entire pilot projects does not necessarily cause reuse of knowledge in subsequent (pilot) projects. The final report is often too large a unit to share knowledge efficiently. The comparison of existing final reports with an ongoing (pilot) project is associated with too much effort and thus the cost-benefit ratio becomes negative. Therefore, we established a common structure for pilot projects. This work introduces six stages which every pilot project should experience. The common structure reduces the cost of sharing knowledge. To that end, they aim to perform intermediate evaluations of projects at the end of each stage.

In this paper, we contribute detailed considerations of the structures that are required to efficiently and effectively share the knowledge which is obtained through these intermediate project evaluations.

Evaluation is necessary as it can contribute to better planning practice. It helps to justify individual projects and their results to citizens, politicians, researchers, and planners. Evaluation also promotes an effective planning dynamic, "in which suggestions for changes or reviews in planning products and processes are supported by the results of evaluation exercises" (Oliveira and Pinho, 2010, p.354). But most importantly, it enables the construction of planning practice based on a continuous learning process which contains sufficient mechanisms by enabling the permanent exchange of data between theory and practice (Oliveira and Pinho, 2010).

To obtain an effective evaluation, planning practice should be evaluated as a whole. Thus, the evaluation methodology should assess the different stages of a pilot project and also contain a continuous process of learning and diffusion with effective mechanisms facilitating the durable transfer of data between theory and practice. Furthermore, the planning process and the evaluation process have to be developed together from the start as both are cyclic processes. Therefore, a number of correlations between both should exist. In so doing, it is possible to provide a set of contributions and results that can be used in due time. It follows, that the evaluation has to comprise the whole life cycle of the project and that its processes have to involve ex ante, ongoing, and ex post dimensions (Oliveira and Pinho, 2010).

To learn from and ensure the applicability of evaluation results in planning practice, it is crucial that the results are presented in an understandable way to different audiences (Oliveira and Pinho, 2010). To achieve this, a model incorporating a systematic interaction between project participants as well as a central collection of knowledge is required. The collection of knowledge should be open to the public and freely available.

We show that structuring pilot projects into stages and systematically linking them to knowledge management activities is decisive for pilot projects' success in achieving an efficient and effective distribution of knowledge.

2. Background

2.1. Pilot Projects in German Spatial Planning

Experimental research in the form of pilot projects is particularly useful if current or future research questions cannot be adequately clarified in a different way. Furthermore, pilot projects may be initiated for urgent current challenges in order to develop transferable solutions for other regions or municipalities facing the same issues. They are specifically designed for such challenges and are evaluated with reference to them. In order to do so, a detailed appraisal is carried out to determine whether the originally defined objectives have been achieved and whether the results can be reused on a larger scale. Pilot projects differ from classic product- and result-oriented research assignments that primarily include a reflected conception and systematic preparation as well as evaluation of existing experiences and know-how. Pilot projects focus on the process-accompanying analysis of research questions and objectives, implementation strategies as well as the realisation of measures. Thus, pilot projects are rather process- than product-oriented.

Within a single pilot project, various regions or municipalities carry out different (sub-) projects over a predefined period of time. The regions or municipalities interested in participating have to formally apply. Participants are selected by the initiator on the basis of different criteria. Thus, pilot projects are a competitive tool for spatial development. “The compelling application of the principle of competition ensures more innovation and a higher quality of the pilot projects” (Gatzweiler, 2006, p.689). However, the principle of competition and, in particular, its execution also possesses a negative aspect; it may lead to premature bidding regarding ambiguous conditions. Furthermore, there may be unsatisfactory selection procedures in the case of a limited number of participants, and a disproportion between work expenditure and income may emerge (Becker, 2010). Additionally, the success of pilot projects is not automatically guaranteed, but can be positively influenced by the selection of potentially innovative ideas of the applicants.

During the execution of a pilot project, obstacles may arise challenging the various stakeholders. Obstacles are, e.g., the involvement of external authorities, a lack of expertise in the subject area, or a too short preparation phase. The concept of a model municipality or region can fail during the course of a pilot project. For this reason, multiple municipalities or regions should participate in pilot projects to increase the probability of achieving successful results. In this way, the suitability of the acquired problem solution can be tested in practice (Einig, 2011). Another benefit of participation of as many model municipalities or regions as possible is the exchange and sharing of various experiences.

During the execution of a pilot project, exchange of experiences between the participants involved in the pilot project is organised and may include reporting upon the current progress of the given pilot project. In this way, the process orientation becomes evident. The selection of pilot projects aims to ensure a safe generalisability and transferability of the obtained results to other regions and municipalities with similar challenges (Steinebach, 1992; Gatzweiler and Runkel, 1997; Wiechmann, Mörl and Vock, 2012).

Academic or private institutions scientifically monitor pilot projects in order to identify generally valid results that show potential for general validity and thus reusability (Gilcher and Steinebach, 2018). The initiator finances the scientific monitoring. Continuous appraisal of activities implemented in the (sub-) projects is most important. Therefore, cooperation between the scientifically monitoring institution and executing local stakeholders is a priority task. Creation of an extensive network of individual (sub-) projects is another goal of this activity. In particular, regular briefings of all involved parties about the results of all projects in the research field are important as they ensure that an exchange of experiences takes place. Scientific monitoring also includes the preparation and transfer of the results of individual (sub-) projects to different target groups as well as the undertaking of networking with relevant national and European research activities. On the basis of the gathered experience, indications for the preservation or further development of the federal planning and housing policy frameworks of the Federal Republic of Germany are derived (BfLR, 1992). Academia takes a more important role compared to the established conception processes of the federal government and the federal states in Germany (Einig, 2011).

We identified a common structure for pilot projects to efficiently share knowledge: identification of a novel challenge, project initiation and public bidding, applications of potential participants, evaluation of applications by the initiator, execution, final evaluation (Gilcher and Steinebach, 2018).

The phases of a pilot project methodically follow the phases of project management: initiation and definition, planning, execution, and closure. The number of project phases and the formalism used for their implementation clearly depends on the nature, scope, risk and importance of the given project as well as the influence of the client (Kuster et al., 2015; Project Management Institute, 2017).

Each stage of a pilot project is now briefly described in order to provide the first contribution of this paper: a pilot project’s lifecycle resembles the non-iterative waterfall model.

1. *(Identification of a new challenge)* The federal government or states apply pilot projects if a novel challenge of spatial planning is identified and its research questions cannot be answered in a different way. Such a challenge is characterised by its having a significant impact on spatial planning, e.g. demographic change, economic structural change, sustainable development, climate change and climate protection as well as environment protection. These challenges have several consequences at federal, federal state, regional and municipal levels, and solutions to them have to be found (Gilcher and Steinebach, 2018).

2. *(Project initiation and public bidding)* The application process consists of two stages. In the first stage, meaningful project outlines have to be submitted for each project proposal. The received project proposals are evaluated according to various criteria such as the quality of the approach, innovativeness, the qualification(s) of the partner(s), application potential, the applicability of the results for other German municipalities, and issues of transferability. The received and peer review-enabled project proposals are assessed according to the listed criteria, potentially with the help of external reviewers. Based on the reviews, the project ideas which are deemed appropriate for funding are selected. In the second stage of the application process, the promoter asks the applicants of positively evaluated project proposals to submit an official application for funding. In a final appraisal, it will be decided if the project is to be funded (Gilcher and Steinebach, 2018).

3. *(Applications of potential participants)* The public bidding of a pilot project attracts many applicants from various stakeholders that are intended to take part. Depending on the public bidding, it is possible that stakeholders may apply individually or in groups (Gilcher and Steinebach, 2018).

4. *(Evaluation of the applications by the initiator)* The initiator evaluates the received applications on the basis of various criteria. The most important is the innovativeness of the application's proposal in order to cope with the novel challenges researched in the project. The criteria also include if the municipality can serve as a comprehensive example (Gilcher and Steinebach, 2018).

5. *(Execution)* During the execution of the pilot project in the selected municipalities, research questions are examined and strategies as well as measures are implemented. To ensure the process-orientation, a collaboration of the participants, an exchange of experiences between collateral pilot projects, and a continuous communication of running pilot projects to an expert audience take place (Gilcher and Steinebach, 2018).

6. *(Final Evaluation)* A pilot project is completed with a final presentation and a final report written by the academic or private institution entrusted with the scientific monitoring. Furthermore, generally applicable criteria have to be identified and transferred to large-scale problem solutions (Gilcher and Steinebach, 2018).

These stages occur in a sequence and each stage is executed only once during the life of a pilot project. Thus, the lifecycle of a pilot project resembles a waterfall-model. The waterfall model was first defined by Winston Royce in 1970 in the context of software development (Royce, 1970). However, it is more generally applicable and its fundamental insights on sequential, non-iterative processes are transferable to other scientific disciplines such as the urban and regional planning context of this paper. The model takes its name from a waterfall because the progress is seen as flowing steadily downwards (like a waterfall) through the different stages (see Figure 1). The number of stages varies depending on the project, but there is a clear transition from one stage to the next once the previous stage is completed. Thus, requirements for the next stage are known before they are entered. Each stage has a predefined start and end point and proceeds in order without any overlapping. Originally, feedback to previous stages of the process could only be applied to the immediately preceding stage, yet, in spatial planning's pilot projects this is not the case. As this is a linear model, it is easy to implement and, as a result, many projects besides software development and spatial planning contexts follow this waterfall lifecycle model. A further benefit of the model is the minimal amount of resources that are required for its implementation as it is neither iterative nor possesses overlapping stages. For pilot projects, this also allows for different stages to be executed by different stakeholders as outlined in the brief descriptions above. However, these two properties also impose weaknesses. Foremost, the waterfall model is unsuitable for projects with many unpredictable factors that require more flexible adaptations. Furthermore, errors in early stages are often only visible at the end of a project – another fundamental similarity between pilot projects and the development of systems that we utilise for this contribution.

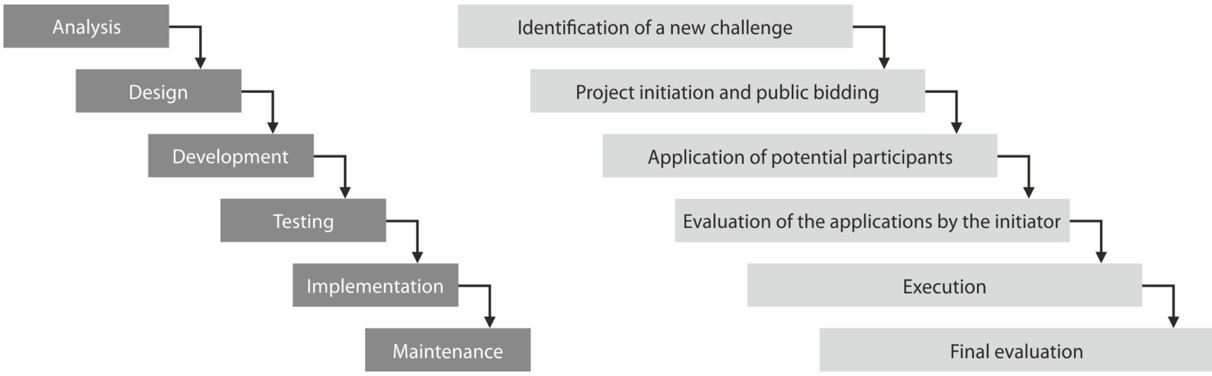

Figure 1 - Waterfall lifecycle model and stages of a pilot project
Source: Authors' illustration, based on Royce (1970).

2.2. Knowledge Management

The main aim of pilot projects is the reusability of previously obtained knowledge in future (pilot) projects as well as spatial planning practice and potentially even legislation. However, thus far existing knowledge has not been saved in a format or a central place that allows for efficient and effective sharing as the final report is too large and not application oriented to efficiently share knowledge. Comparison of existing final reports with an ongoing pilot project's setting is associated with too much effort. i.e., the cost-benefit ratio is negative. It follows, ceteris paribus, that the reutilisation of knowledge is not guaranteed. For this reason, we aim to develop a structure to store knowledge centrally which makes it more readily available. The established stages of a pilot project process are one part of the foundation needed to achieve this goal. In the following, we turn to the second part that is crucial in our context: knowledge management. It consists of three fundamental aspects:

- knowledge
- knowledge management
- the knowledge management process

We first define these and then contribute their integration into the waterfall lifecycle model of pilot projects in *Section 3*.

2.2.1. Knowledge

The hierarchical model comprises the differentiation of data, information, and knowledge (see Figure 2). These terms cannot be sharply distinguished from each other, as transitions between them are blurry. We distinguish these terms as follows:

Data are facts and figures that relay something specific. Data does not exist by itself, it depends on observation (Wilkesmann, 2004). However, they are unorganised, unprocessed and therefore provide no further meta information regarding patterns, context and so on. Thierauf (1999) defines data as "unstructured facts and figures that have the least impact on the typical manager". For data to become information, it must be contextualised, categorised, calculated and condensed (Davenport and Prusak, 2000). Information is data with relevance and purpose (Bali, Wickramasinghe and Lehaney, 2009).

Knowledge is the set know-how and skills that individuals use to solve problems. It includes theoretical insights as well as practical rules of daily life and instructions. Knowledge is based on data and information, but unlike these it is always bound to people. It is built by individuals and represents their expectations about cause and effect relationships (Probst, Raub and Romhardt, 2012).

Knowledge emerges when information is linked and turned into skills through application. It can be incorporated into individuals' actions (Mescheder and Sallach, 2012).

In addition to action orientation, the attachment of knowledge to individuals is of central importance. Knowledge emerges in processes of interaction and is connected with the context of creation. Therefore, it is not neutral, but influenced by interests.

The development process itself is multi-level. It starts with sensory experience and limited understanding. Individuals absorb aspects of reality (environment) through their senses and put them into a context. In these contexts, they recognise laws and generate an individual knowledge of relationships. Over the course of time, various mental models are built to sort and classify past experiences. The expression of the models depends on the intellectual abilities of individuals as well as the social and emotional influences that they are subjected to (Mescheder and Sallach, 2012).

Therefore, knowledge is more than the mere cognisance of a fact. Rather, it forms the basis for purposeful action and solving problems. Combined with experience of judgement and decision-making, this knowledge matures into personal competence. In this context, the bond to individuals becomes particularly clear as mental models as well as the ability to act and decide are bound to people. Beyond the realm of human beings, knowledge can only be partially mapped using objects from structured data and information. The bond to individuals means, in particular, that only small sections can be limitedly represented in the explication or externalisation of knowledge. Another important focus must be placed on the development of personal competence (Mescheder and Sallach, 2012).

Knowledge consists of skills, know-how, and understanding; each are linked to human experiences, insights, feelings, values, and intuitions. Furthermore, knowledge is the theoretical or practical understanding of a subject. It is an intangible asset, whose value is increased through use and sharing. Thus, it can only be assessed in retrospect. It is more complex than unvalued information and cannot be easily stored and processed due to the factors that define its value.

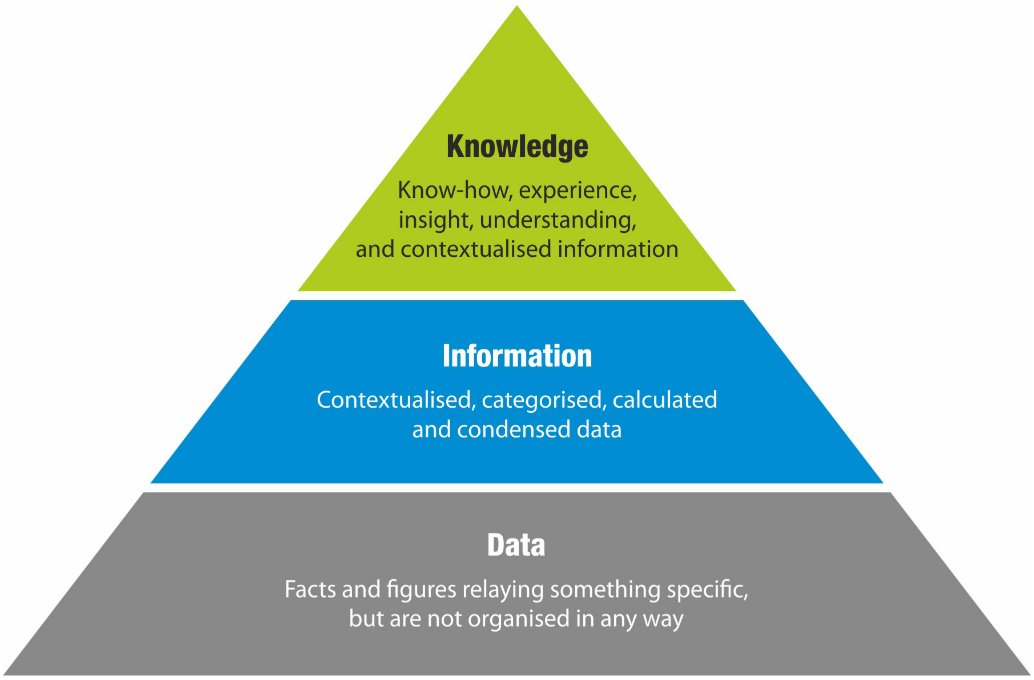

Figure 2 - Differentiation of Data, Information and Knowledge
Source: Authors' illustration.

Various kinds of knowledge can be differentiated from each other and may be designated by contrasting conceptual pairs. Examples include: tacit and explicit, demonstrative and intuitive, and individual and organisational. In the area of knowledge management, the categorisation into tacit and explicit knowledge is most significant. Tacit knowledge is defined as not publicly accessible individual knowledge that it is only accessible to a single organisation. In contrast, accessible knowledge is referred to as explicit knowledge (Bali, Wickramasinghe and Lehaney, 2009).

2.2.2. Knowledge in the Spatial Planning Process

Spatial planning studies differ from many other scientific disciplines as the close relation between theory and practice is their essential and characteristic feature. Scientific studies of spatial planning focus on specific experiences in practice and are therefore highly interwoven with societal networks in order to examine practices. This prioritisation brings more sophistication and intelligence in the scientific elaboration and analysis of spatial planning studies (Salet, 2014).

However, social practices are characterised by extreme ambiguity, complexity, and irrationalities. Therefore, planners have to deal with elusive as well as multi-interpretive aspects of social reality. Planning science cannot aim for presumed certainties of cognitive knowledge and should search for strategies to fundamentally deal with complexity and uncertainty (Salet, 2014).

Their direct engagement with practical experience lets spatial planners realise the multi-faceted nature of knowledge. Thus, in addition to the systematized knowledge, planning knowledge also incorporates other layers such as 'reflection', 'experience', 'emotions' and 'political rationality'. It is often observed that cognitive knowledge is not so practically relevant in the social processes of planning. Therefore, "planning sciences should be aware of investigating the impact of different sources and rationalities of planning knowledge" (Salet, 2014, p.296). Furthermore, spatial planners have learned to see planning processes as target-oriented, but also as open-minded and open-ended processes and to organise them as learning processes (Salet, 2014).

Due to the different properties and levels of knowledge, it is hard to discuss the main core of planning knowledge. As a consequence, a double valorisation of planning studies in practice and in science is necessary. This can happen in two ways: via the regular accountabilities of the scientific world or by those of professional practices. This may be a challenge as these two ways of valorisation are extremely different. According to different traditions and rationalities, different languages and different platforms of dissemination, the same output of research has to be valorised and disseminated. Practical validation of planning knowledge is generally based on networks of cooperation with professional practices and requires a specific language (Salet, 2014).

Whereas scientific research is validated internationally and interdisciplinary. The requirements of scientific validation are criticized as biased to certain scientific cultures and selective to anglicised dominancy (Salet, 2014). In this context, "it is argued that planning studies should define own disciplinary norms of combined practical and scientific accountability" (Salet, 2014, p.302). However, there is no other possibility than the double valorisation as the definition of own disciplinary norms is not compatible in the multi-disciplinary world of science (Salet, 2014).

Spatial planning studies should keep their practice-oriented mission as practical experiences are the main core of planning knowledge. At the same time, however, researchers must present this on the highest platforms of scientific validation (Salet, 2014).

These explanations show that knowledge is bound to people and that knowledge in spatial planning is gained, in particular, from practical experience. In the context of pilot projects in spatial planning, the obtained knowledge is often not shared publicly and is at most only accessible within a single pilot project. A cause of this circumstance could be the lack of an adequate model or framework. We show with our developed structure how knowledge can be transferred between participants of consecutive pilot projects.

2.2.3. Knowledge Management

Knowledge management tries to turn tacit knowledge into explicit knowledge and vice versa. Hence, we share this goal with knowledge management; it demands structured development, distribution, and the utilisation of knowledge. In current times, efficient and effective processes for implementing these management tasks are even more important as the volume of knowledge is not only increasing rapidly but also becoming obsolete faster. Furthermore, a stronger trend towards specialisation in professional environments requires adaptable and convertible knowledge. The resource knowledge should be used consciously to capitalise on it and gain competitive advantage. In theory, the implementation of knowledge management promises multiple advantages that we also aim to achieve for pilot projects:

- less effort for seeking existing knowledge on a subject
- better application of existing knowledge
- more time for generating novel ideas and innovations as reliable foundations are reused
- better internal and external communication
- quicker project activities and better collaboration with partners by transparency of structured and current knowledge

The actively pursued tasks of knowledge management are expansion, utilisation, and the protection of knowledge in an organisational unit. These processes take place on a superior meta-level. In spatial planning these levels are nationwide, regional, municipal or – as in our forthcoming example of sharing between two consecutive pilot projects – project-based.

2.2.4. Knowledge Management Models

Over recent time, interest in learning and knowledge creation processes have grown. As a result, several theoretical models pretending to explain how knowledge is created and transferred have been developed. There are a number of different Knowledge Management models which cumulatively cover the various different perspectives of knowledge. In the following overview, the main models of knowledge management are described.

Knowledge Management Model by Nonaka and Takeuchi (1995)

An established example of a Knowledge Management model is the SECI model of knowledge dimensions originally developed by Nonaka in 1990 and later further refined by Takeuchi. It is a model of greater diffusion and has had a great impact in the academic world. It considers knowledge management as a knowledge creation process and presumes that knowledge consists of tacit and explicit elements. The model assumes that knowledge is created through the interaction between tacit and explicit knowledge. This allows the postulation of four different modes of knowledge creation (Nonaka and Takeuchi, 1995).

In this model, tacit knowledge (subjective) is defined as nonverbalised, intuitive and unarticulated. Knowledge of experience (body) is tacit, simultaneous knowledge (here and now) as well as analogue knowledge (practice) which tends to be tacit. Whereas explicit knowledge (objective) is articulated and can be specified in, for instance, writing, drawings, and computer programming. It encompasses knowledge of rationality (mind), sequential knowledge (there and then) and digital knowledge (theory). At the core of the theory is a description of the functionality of the model. It is based on the four dimensions of knowledge transformation which are the driving forces behind the knowledge creation process: Socialization, Externalization, Combination, and Internalization (Nonaka and Takeuchi, 1995).

The model assumes that tacit knowledge can be transferred into tacit knowledge through a process of Socialization, e.g., sharing tacit knowledge face-to-face or through experiences. Tacit knowledge can become explicit knowledge by formalising a body of knowledge or through a process of Externalization. Explicit knowledge can be directly transferred into explicit knowledge by combining various existing theories, known as Combination process. Internalization is the process of understanding and absorbing explicit knowledge into tacit knowledge undertaken by individuals (Nonaka and Takeuchi, 1995).

This knowledge management model presumes that knowledge transfer in organisations is simple and straightforward. However, knowledge transfer in organisations can be more complex. The individual modes of knowledge conversion may create knowledge independently from each other. However, the organisational knowledge creation processes only occur when all four modes are managed so that they interact dynamically (Nonaka and Takeuchi, 1995).

This highly iterative process constitutes a 'knowledge spiral' (see Figure 3) which occurs mainly through informal networks of relations in an organisation starting from the individual level, and then moving to the collective level before eventually to the organisational level. It creates a 'spiralling effect' of knowledge accumulation and growth which promotes organisation innovation and learning. In order to achieve organisational knowledge development, the knowledge has to be made accessible again through Socialization. As a result, the spiral restarts (Nonaka and Takeuchi, 1995).

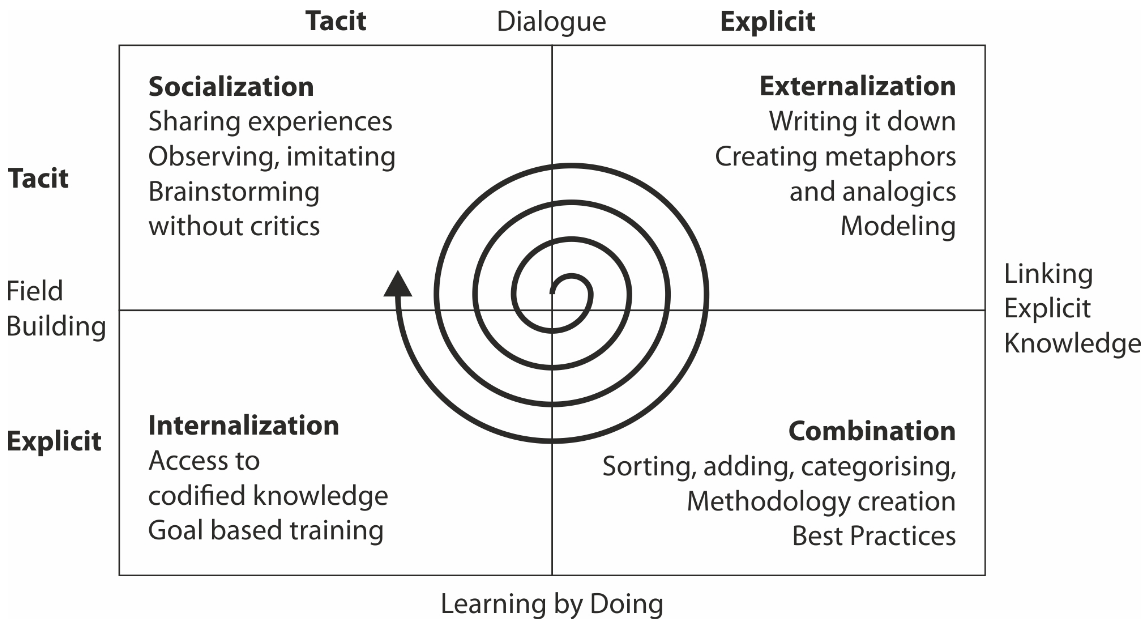

Figure 3 - Knowledge Spiral
Source: Authors' illustration, based on Nonaka and Takeuchi (1995).

The Boisot I-Space Knowledge Management Model (1998)

Another example of a knowledge category model is the approach taken by Boisot (1998). He added the extra dimension of 'abstraction' to the model of Nonaka and Takeuchi. Boisot's model asserts that knowledge can be generalised to different situations. Two main points are proposed

- That the more easily data can be structured and converted into information, the more diffusible it becomes.
- That the less that structured data requires a shared context for its diffusion, the more diffusible it becomes (Dalkir, 2011).

These propositions underpin a simple conceptual framework – the Information Space or the I-Space KM model. Data is structured and understood through the processes of codification and abstraction. The model can be visualised as a three-dimensional cube with dimensions for degree of codification, degree of abstraction and degree of diffusion (Dalkir, 2011).

Boisot suggests a *Social Learning Cycle (SLC)* using the I-Space to model the dynamic flow of knowledge through a series of six phases:

In the phase *Scanning*, insights are gained from generally available *(diffused)* data. The knowledge becomes *codified* in the *Problem-Solving phase* by giving it structure and the insights, coherence. The newly codified insights are generalised to a wide range of situations. Accordingly, in this phase knowledge becomes more and more *abstract*. Further, knowledge becomes *diffused* by sharing the insights with a target population in a codified and abstract form. In the phase of *Abstraction*, the newly codified insights are applied to a variety of situations which, in turn, produce new learning experiences. Overall, knowledge is absorbed, produces learnt behaviour, and becomes uncodified or tacit. In the last phase *(Impacting)*, abstract knowledge gets embedded in concrete practices such as artefacts, rules, or behaviour patterns (Dalkir, 2011).

The SLC-model (see Figure 4) links content, information, and knowledge management in an effective way. The dimension of codification is connected to categorisation and classification, the abstraction dimension is linked to knowledge creation, and the dimension of diffusion is connected to information access and transfer.

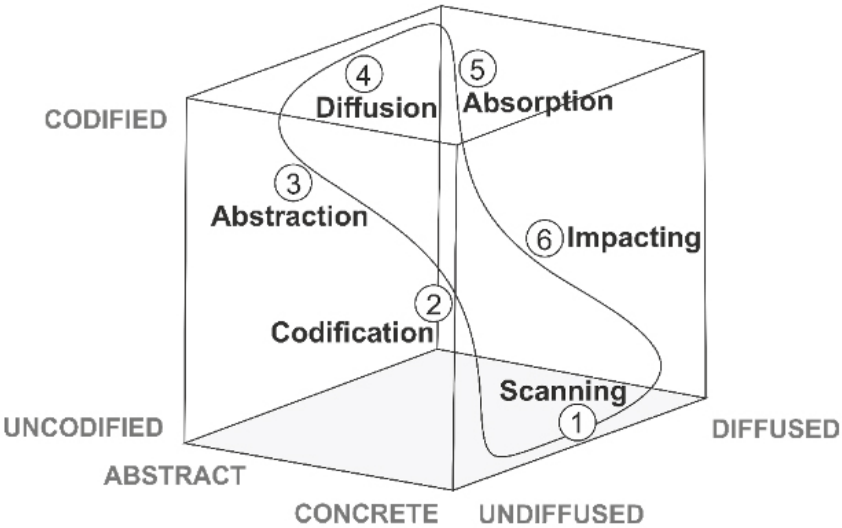

Figure 4 - I-Space Model
Source: Authors' illustration, based on Boisot (1998).

Tannenbaum and Alliger (2000)

Other authors define different stages representing the development of knowledge but do not enhance them iteratively.

Tannenbaum and Alliger (2000) claim that four major aspects of Knowledge Management jointly determine its effectiveness. They examined Knowledge Sharing, Knowledge Accessibility, Knowledge Assimilation, and Knowledge Application. Knowledge Sharing is defined as the scope to which people share their knowledge. The access of people to the information they need to make decisions, solve problems, perform job tasks and service customers is Knowledge Accessibility. The scope to which people learn or assimilate the knowledge they need to perform well is the definition of Knowledge Assimilation. Finally, Knowledge Application is the extent to which people apply or use knowledge to effectively make decisions, solve problems, and service customers. The last aspect (Knowledge Application) is of great significance for efficient knowledge management. However, each of the previously described aspects contributes to the application of knowledge (Ortiz Laverde, Baragaño and Sarriegui Dominguez, 2003).

McElroy (2003)

McElroy created a framework of Knowledge Management called 'The knowledge life cycle' (KLC) (see Figure 5). In comparison to the model of Nonaka and Takeuchi, it supposes that knowledge exits only after it has been produced. After this step, it can be captured, codified, and shared (McElroy, 2003).

McElroy split the Knowledge Creation Process into two processes Knowledge Production and Knowledge Integration (McElroy, 2003).

In the phase of Knowledge Production, knowledge must first be deemed worthy before proceeding further. This validation process results in the formal acceptance and adoption of new organisational knowledge. A claim must be formulated and evaluated by processes of individual and group learning as well as through information acquisition. If the claim is valid, the knowledge is codified and circulated throughout the organisation. Knowledge is discarded if the claim is declared invalid. The third possible result is that the claim is uncertain. In this case, additional steps must be taken to further assess the usefulness of the content. This process is repeated until a decision can be made (McElroy, 2003).

The second phase of the model is Knowledge Integration and involves the sharing and dissemination of newly validated knowledge. Knowledge is held by individuals as well as by groups. In addition, this phase identifies whether the given knowledge will fulfil the given business' expectations or is incapable of so doing. A match results in reutilisation. If there is a mismatch, the individual and/or organisational behaviour will be adjusted. This, in turn, results in more learning. Nevertheless, it must be taken into account that these adjustments require "acts of willful transformation, both by the sponsor of the new [knowledge], as well as by the workforce that the changes affect" (McElroy, 2003, p.76).

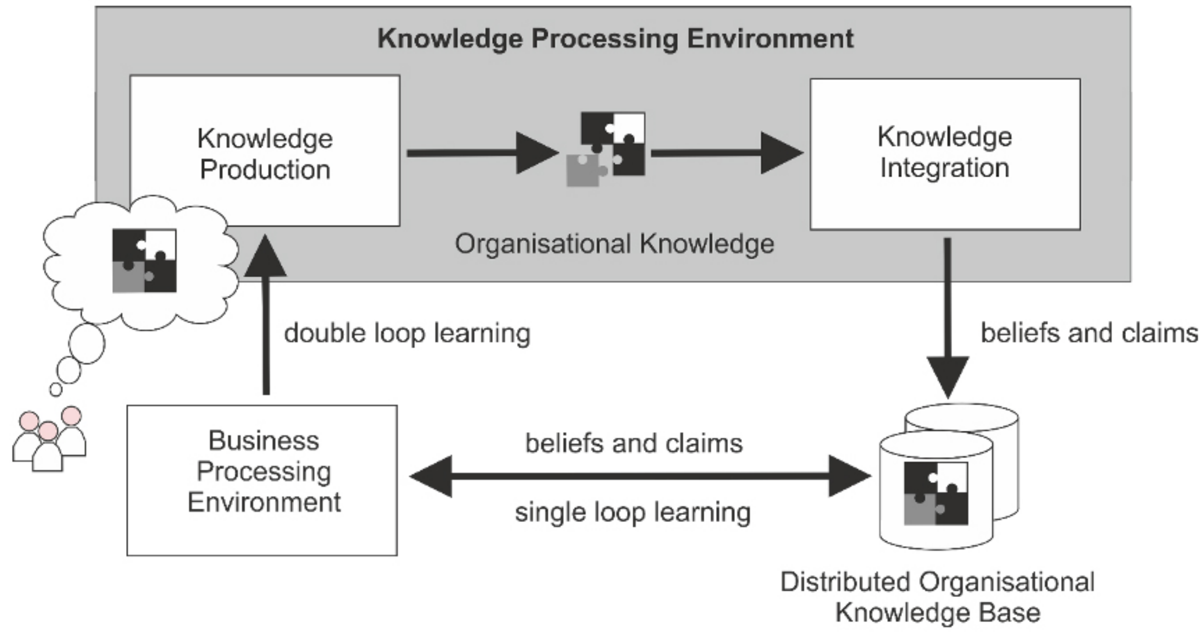

Figure 5 - Knowledge Life Cycle (KLC)
Source: Authors' illustration, based on McElroy (2003).

Skandia Intellectual Capital Value Scheme (1997)

Knowledge Knowledge management is also regarded as intellectual capital. The internationally operating Swedish insurance company Skandia developed an intellectual capital model of knowledge management as an approach for measuring its intellectual capital.

Intellectual capital consists of human capital and structural capital. Dimensions that "are left behind when staff has gone home" is the definition of structural capital. However, structural capital may be owned or shared from a shareholder's point of view. Human capital can only be rented and is not owned (Roos et al., 1997).

An initial model was developed to define different categories of intellectual capital. As shown in Figure 6, market value is divided into financial capital and intellectual capital. Intellectual capital encompasses human capital and structural capital. The latter covers customer capital and organisational capital, which can be subdivided into process capital and innovation capital. Moreover, a more detailed perspective was provided with a further division of organisational capital into two additional building blocks; process capital (intangible assets) and innovation capital (intellectual property) as a balancing item (Roos et al., 1997).

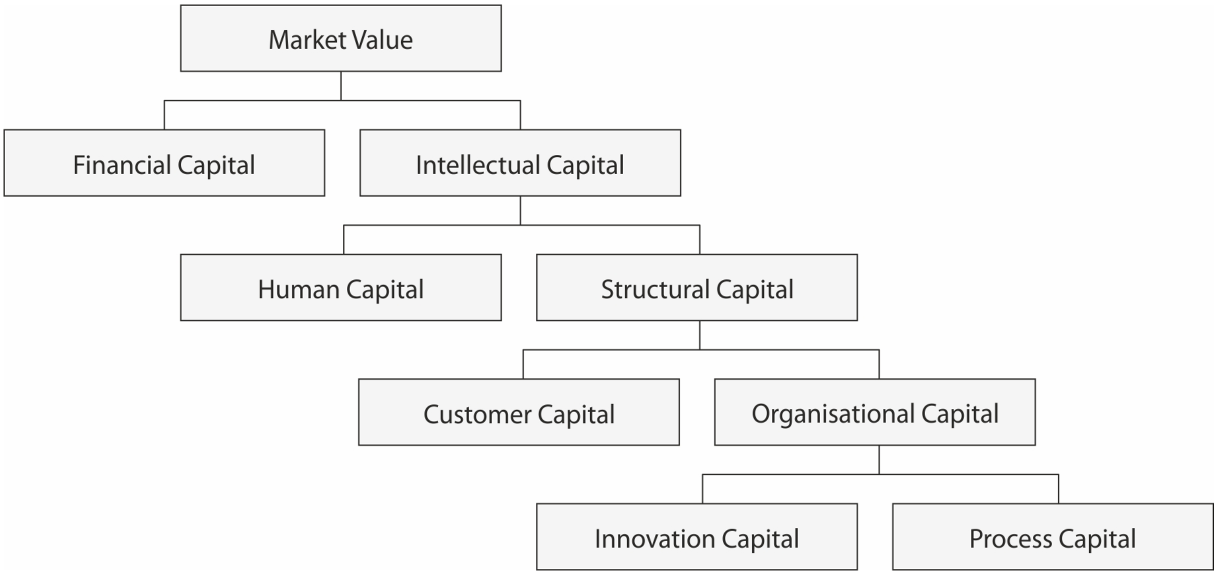

Figure 6: Skandia Model
Source: Authors' illustration, based on Roos et al. (1997).

The Skandia Intellectual capital Value Scheme strongly emphasises the measurement tasks associated with each of the divided elements of knowledge management. It presumes that it can be strictly controlled (Roos et al., 1997).

Probst, Raub and Romhardt (1998)

A more practical approach to managing knowledge is the building block model of Probst, Raub and Romhardt (1998). It was developed in close dialogue with practitioners and always kept the following criterion in mind: "How useful is the model in relation to a chosen question?" (Probst, 1998, p.18).

As in every planning and implementation process, four fundamental aspects have to be observed in knowledge management: purpose definition, situation analysis, deduction of measures based on a nominal-actual-comparison, and success monitoring. Note, that we can find these four aspects reflected in our six stages of a pilot project as well. Probst, Raub and Romhardt (2012) differentiated the four aspects in order to implement phases of knowledge management.

Their method of knowledge management includes eight building blocks, each representing activities directly related to knowledge. Their arrangement in the model follows specific principles. Six building blocks form the key process of knowledge management. Two blocks form an orienting and coordinating frame for this key process. The feedback cycle shows the importance of measuring the measurable variables to focus on goal-oriented interventions (Probst, 1998). Division of the key process of knowledge management is explained below as well as being depicted in Figure 7. In Section 3, we show the integration of a knowledge management model into pilot project's lifecycle.

(knowledge goals) The first step is the definition of knowledge goals. These outline which abilities should be established at which level. Normative (influencing the business culture), strategic (aim for future competence requirements) and operational (target on specific implementation) knowledge goals can be differentiated (Probst, 1998).

(knowledge identification) The identification of knowledge aims to obtain an overview of internal and external data, information and skills, before investing heavily in the development of new capabilities (Probst, 1998).

(knowledge acquisition) Knowledge acquisition refers to the acquisition of external knowledge holders or even the purchase of knowledge products such as software or patents. Important channels to acquire critical capabilities include knowledge held by other firms and people, stakeholder knowledge, experts, and knowledge products. In this way, the body of knowledge can be extended, existing knowledge gaps can be closed and the setup of future or current required competencies accelerated. Furthermore, it is important to realise whether an acquisition is an investment in the future or an investment in the present. Integrated knowledge management is involved in both areas and support their management with the right tools (Probst, 1998).

(knowledge development) Knowledge development is an additional phase to knowledge acquisition. The knowledge that cannot be covered by the acquisition has to be developed internally (Probst, 1998).

(knowledge sharing) Knowledge has to be divided and distributed in case it is supposed to be used consciously or even unconsciously. In order to make knowledge available and usable, the critical questions to be answered are: Who should know what, to what level of detail, and how can the organisation support these processes of knowledge distribution. Regardless of the circumstances, knowledge should never be distributed randomly. Groups or individuals should have access to exactly the knowledge relevant to their specific tasks (Probst, 1998).

(knowledge utilisation) Knowledge utilisation is the productive application of organisational knowledge. It is the purpose of knowledge management. Effective identification and distribution of critical knowledge does not, however, guarantee its regular use. Without consistent use, knowledge systems decay in quality, and initial investment is lost without generating sustained added value. Potential users of existing knowledge have to perceive the immediate advantages which result from changing their behaviour and 'adopting' the knowledge (Probst, 1998).

(knowledge preservation) To obtain valuable experiences, a process of selection has to be created and results have to be appropriately saved and updated thereafter. In order to avoid the loss of valuable expertise, processes of selecting valuable knowledge for preservation must be established to ensure its suitable storage and its regular incorporation into the knowledge base (Probst, 1998).

(knowledge evaluation) The evaluation and measurement of the achievement of knowledge goals is the focus of the last step and is the biggest challenge in the field of knowledge management. Knowledge and capabilities are very elusive and can rarely be tracked to a single influencing variable. In addition, the cost of knowledge measurement is often seen as too high or socially unacceptable. However, the evaluation of knowledge holds considerable potential to generate value (Probst, 1998).

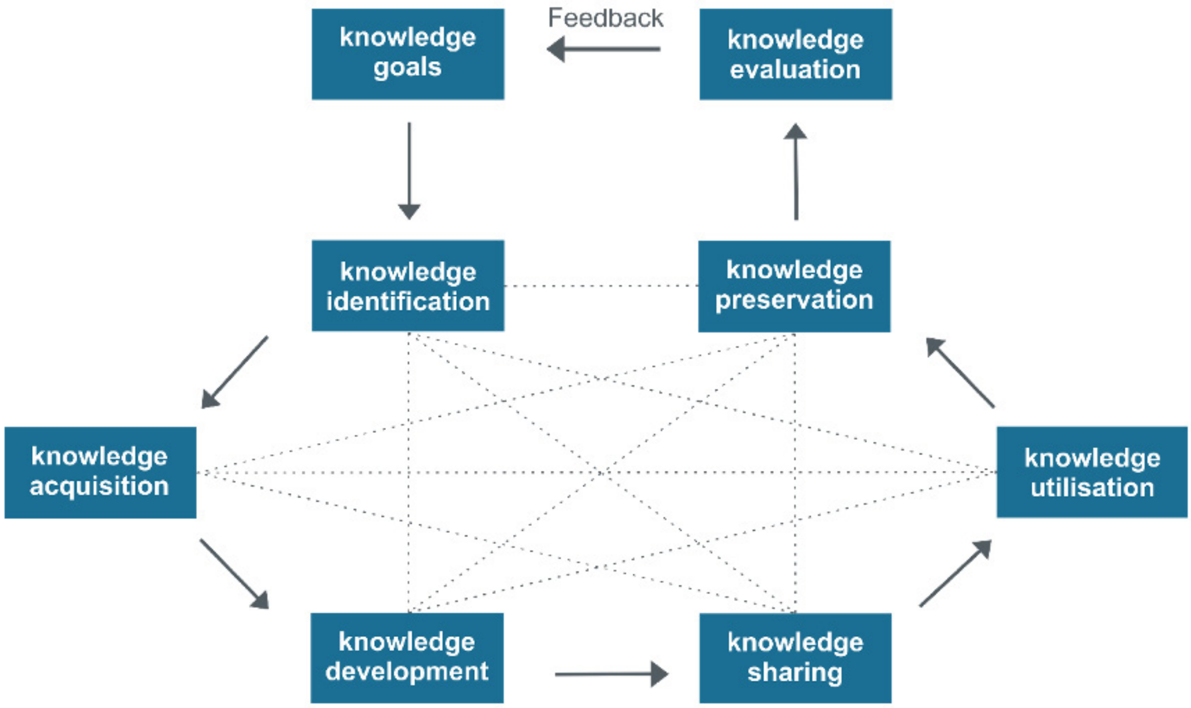

Figure 7 - Building Blocks of Knowledge Management
Source: Authors' illustration, based on Probst, Raub and Romhardt (2003).

The Knowledge Management Model as a Basis for Our Developed Structure

We have described different models of knowledge management. The basis of most models is a learning cycle that is influenced by framework conditions or hindered by learning barriers. There is no 'right' model of knowledge management. The different systems are the result of different cognitive interests and observer perspectives.

The framework of Probst, Romhardt and Raub emphasises the interdependence of the building blocks. The individual blocks correlate and interact. Thus, the activities of knowledge management should never be conducted in isolation from one another (Probst, 1998). This major advantage is very important for the development of our model.

Furthermore, their model is guided by a practice-oriented interest in understanding. It is a practical approach to improve organisational capabilities through the better use of the individual and collective knowledge resources of an organisation. As practical experience is the main core of planning knowledge, this is also an important point for the suitability of this knowledge management model. The definition of the building blocks of knowledge has further advantages: the knowledge management process is structured in logical phases, approaches for interventions are offered, and a proved framework for diagnosing the sources of knowledge problems is provided (Probst, 1998).

Based on these positive characteristics, we decided that this model was best suited for integration into the pilot project lifecycle.

It is suggested by Probst, Raub and Romhardt (2012) that these phases are processed in a circular flow, starting with the definition of the knowledge goals. The results of the knowledge evaluation are then fed back into the knowledge objectives. In a less idealised setting, the individual phases are strongly interconnected (see Figure 7), i.e. a multitude of different orders of these phases is possible. We will use this degree of freedom when we exemplify how to incorporate knowledge management into the phases of pilot projects. In particular, this is necessary as the waterfall lifecycle modelnn is non-iterative. I.e. we cannot feed back into the objectives of the same project. Thus, we will focus our illustration on the sharing of knowledge between two consecutive pilot projects.

3. Structure to Efficiently Share Knowledge Obtained in Pilot Projects

The goal of our work is to provide a means to centrally store (preserve) and efficiently share knowledge obtained in a pilot project. To achieve this, we aim to create a novel structured approach, derived from the stages of pilot projects' common waterfall lifecycle and the phases of knowledge management. To that end, we also identify the parts of knowledge management that need to be transferred into a central, external and independent infrastructure. This infrastructure should be accessible to any pilot project. We start with an analysis of the management process that is targeted towards the requirements of pilot projects.

The definition of the knowledge management process by Probst, Raub and Romhardt has various strengths. It structures this management process into logical phases that can occur within the stages of a pilot project. Moreover, it offers approaches for interventions and it provides a proven search framework for the causes of so-called knowledge problems – two further features that can be used by pilot projects. At the same time, it is emphasised that the individual phases interact with each other and that phases of the process may not necessarily be considered in isolation. As pilot projects are non-iterative and have a definite end, we will investigate this last aspect in order to preserve knowledge beyond a pilot project's life. In this context, the planning principles and processual method in spatial development processes have to be the focus. Therefore, the stages of a pilot project are the guiding principle for the integration of the lifecycle of knowledge management.

Knowledge management is a cross-sectional task that undergoes all stages of a development process – in our context, this is the development and execution of a pilot project captured in the waterfall model. The organisational structure of the development process has to support activities that identify, share, and use, as well as preserve and evaluate relevant knowledge. In a pilot project, these tasks may be split between the different participants, depending on the current phase. For example, all the tasks need to be executed by the project initiator in stage 4 (Evaluation of the application by the initiator). Yet, in stage 5 (Execution), the scientific monitoring should be responsible for identification and evaluation and the pilot municipality should establish use of existing knowledge. We propose that preservation and sharing should be provided by a central, external and independent infrastructure.

To achieve this in an efficient and effective way, several aspects have to be considered. Identification of knowledge is currently the most time-consuming task. A structured and consequent approach to this challenge, pursued from the start, may extend the initial phase of the project implementation. Holistic approaches are necessary if knowledge is to be handled in a structured way. Punctual activities are not effective. The organisational structures – planning and project implementation processes – must allow a structured handling of knowledge. If knowledge and information are easily accessible for planning and project implementation, this potential drawback can be mitigated.

Until now, the elements of knowledge management were only deployed in the final stage of pilot projects when the given project's lifecycle reached its end, i.e. its unit of operation was the project's final evaluation report. It is the final evaluation report's purpose to identify, distribute and preserve the knowledge gained in the pilot project. This procedure was supposed to ensure that these have after-effects on planning practice and were transferred to municipalities that strongly resemble the pilot municipality. However, our observations of current pilot projects (Steinebach, Gilcher and Felz 2018) reveal that existing knowledge is not necessarily used effectively and efficiently. The comparison of the results in a previous pilot project's extensive evaluation report with the challenges of a given pilot project is equivalent to the identification of internal or external available knowledge, the most time-consuming knowledge management phase. Given that the definite duration of a pilot project causes time restrictions and that there is lack of automation to assist with this task, this phase cannot be executed exhaustively. Knowledge remains unrecognised and is often just taken into account later, e.g. in the final evaluation of the given pilot project.

Therefore, we propose that each stage of a pilot project should undergo its own individual knowledge management process. This is possible as the stages of a pilot project are strictly separated from each other and proceed in a singular direction of succession – i.e. we make use of the properties of the waterfall lifecycle model and the fact that each phase ends with an evaluation.

The advantage of our proposition is that only small parts of a pilot project's lifecycle have to be completed before the obtained knowledge can be stored and shared. When smaller units of a pilot project undergo the process of knowledge management, knowledge gained in a single stage can be collected, stored, and shared. These smaller units of information are also easier to compare and, thus, the knowledge identification, acquisition, and utilisation become less time-consuming tasks. It follows, that their potential to be reused in future pilot projects as well as further planning practices is improved as the cost-benefit ratio improves significantly. This also allows reuse of current insights as the pilot project providing them need not have already terminated.

The development of this structure, integrating the phases of a knowledge management process into the individual stages of a pilot project, is key to achieving this goal. Figure 8 illustrates the structure on the example of two consecutive pilot projects. Pilot Project 1 integrates parts of a knowledge management process (blue) into its project stages. Relevant phases to be executed are knowledge objectives, knowledge identification, knowledge acquisition (for the purpose of presentation this is assumed to be internal only), knowledge development, and knowledge evaluation. These phases have been rearranged to suit the pilot project's stage. Most importantly, the two phases of knowledge preservation and knowledge sharing have been moved into a novel sharing infrastructure that exists outside of, and thus independently from, the pilot project's lifecycle. It is supposed to persistently store the results of knowledge evaluation and potentially knowledge development, too. This central infrastructure should be used by all pilot projects for knowledge preservation and knowledge sharing. This is illustrated by the consecutive pilot project, Pilot Project 2. The latter has its own knowledge management process (green), and uses the central infrastructure. Most importantly, the knowledge utilisation for Pilot Project 2 should use the results from Pilot Project 1. Moreover, knowledge identification and acquisition can make use of the centrally available source for knowledge for this stage of a pilot project. This scheme repeats in every phase of the waterfall lifecycle (not depicted).

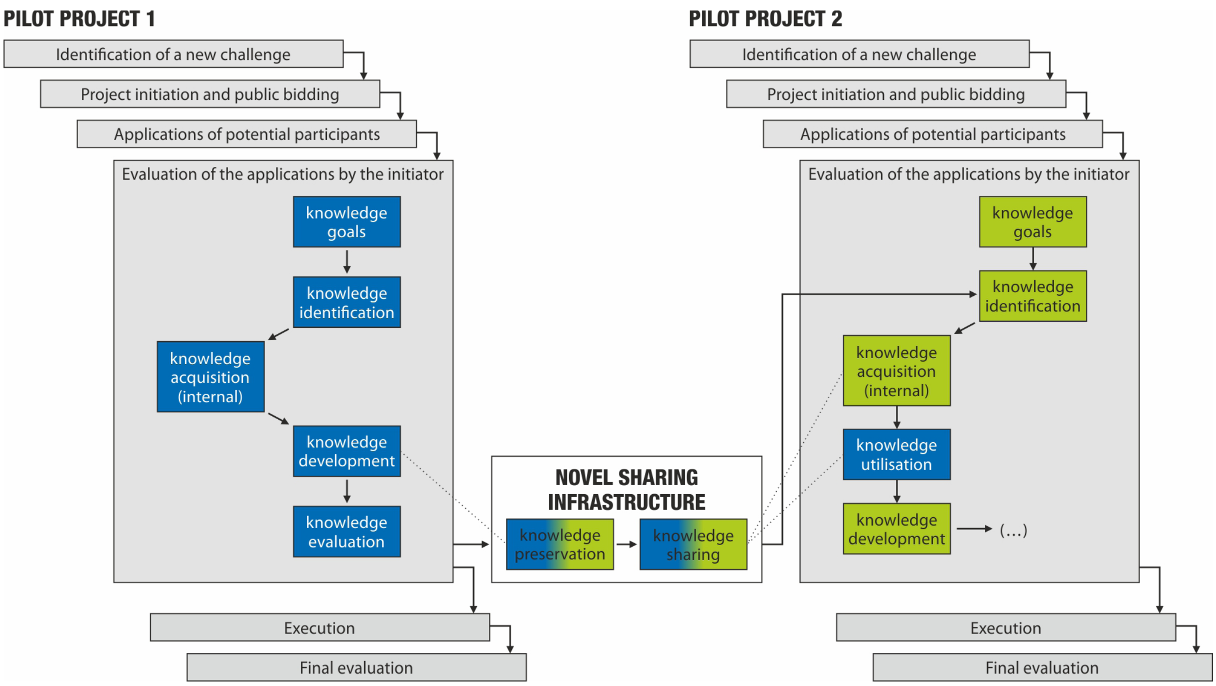

Figure 8 - Integration of knowledge management into the waterfall lifecycle of pilot projects
Source: Authors' illustration.

In knowledge management, learning processes can be identified as new knowledge, whilst skills (learning) is individually constructed. The individual understands new elements and links them with prior knowledge and awareness. Knowledge is created at four levels: individual, group, organisational, and inter-organisational (Barbat, Boigey and Jehan, 2011; Turner, Fünfgeld and Robertson, 2016).

Three models of learning can be differentiated. Single-loop learning is the adaptation to environmental changes through action. Double-loop learning causes a change in values with regard to the theory of use and strategies. Triple-loop learning highlights the possibility of 'learning about learning' or 'learning to learn' and learning lessons from experience. Thus, multi-loop learning means analysing lessons (failures as well as successes) and translating these into updated and more informed decisions in the future (Barbat, Boigey and Jehan, 2011; Turner, Fünfgeld and Robertson, 2016). In the context of these models, knowledge is created, retained and transferred within an organisation. In contrast, the preservation and sharing of knowledge as well as learning lessons from experience takes place between organisations. However, inter-organisational learning brings further complications, such as issues of knowledge consistency. At some stage of their adaptation process, most organisations develop formal training and capacity-building programs and tools to support staff (Turner, Fünfgeld and Robertson, 2016). Therefore, we developed a special framework for pilot projects just as organisations often develop special solutions for multi-loop learning.

4. Conclusion

In this paper, we identified the lifecycle of a pilot project to correspond to the waterfall lifecycle model of development projects. This categorisation of the proceedings of pilot projects allows for reuse of the known properties of a waterfall lifecycle. Most notable is the non-iterative nature of these projects that manifest in non-overlapping subsequent stages that do not incorporate feedback. As we aim for the efficient and effective sharing of knowledge, the latter property is very important. It contrasts to the fundamental feedback step of the knowledge management process we proposed to integrate into pilot project stages. To that end, we presented concepts to overcome this mismatch and to integrate knowledge management into the lifecycle of pilot projects. As mentioned, this integration repeats for every stage in order to reduce the unit of sharing from a comprehensive final project evaluation report to smaller pieces of information. This should reduce the effort of knowledge identification, acquisition and utilisation; i.e. it improves the cost-benefit ratio of these steps of knowledge management and makes them attractive for pilot projects. In this paper, we presented the required background and contributed a theoretical solution for the integration of knowledge management into pilot project stages. Moreover, we exemplified the knowledge preservation and sharing via a novel, external sharing infrastructure through an example of two consecutive pilot projects. In the future, we aim to investigate benefits of digitalisation and automatization as means by which to further simplify knowledge identification and acquisition. We plan to implement our concepts on a small scale and test it on data from pilot projects that we have previously monitored.

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