Toward a Conditional Design Theory for Electronic Knowledge Brokers

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Abstract

This paper reports about a PhD research project in progress on the conceptual design of electronic brokers that support the identification, acquisition and utilization of new product development knowledge by high-tech companies. Objective of the research is to develop and test a conditional design theory, leading to a number of archetypical configurations of electronic knowledge brokers. Currently the research is in its theory development phase.

1 Introduction and Motivation

After the Internet bubble, companies have a hard time to survive online and willingness to pay for online services is low amongst most Internet users. This applies to web sites that are in the focus of our research as well: those that perform technology-brokering tasks, which we label electronic knowledge brokers. These web sites take an intermediating position between actors that need knowledge for their product development and actors that supply this knowledge.

Although part of users' low willingness to pay might be explained due to the history of the Internet – in which free use was common sense – we argue in this research that the lack of a good design *from a demander perspective* is debit to this as well (in this research we only refer to design as a product, not as a process). We observe that this lack of adequate design is caused by a lack of a connection to the actual process in which these websites will be used by demanders of knowledge. In the case of electronic knowledge brokers, this process is defined as what we call *knowledge integration* (KI) and consists of the identification, acquisition and utilization of knowledge outside an organization.

This lack of a demander perspective is reproduced in literature as well. Moreover, with a few exceptions [Rose, 1999; Vishik & Whinston, 1999], literature on broker design focuses on market rather than knowledge brokers. To fill a small part of the emptiness that exists around sound theories on the conceptual design of knowledge brokers, the targeted core contribution of this research is the development of such a theory.

The resulting theory will have practical relevance as well for the ex ante and ex post evaluation of the conceptual design of electronic knowledge brokers. As such, it contributes to a better design of such websites.

To avoid shallowness, the research is limited to a particular context: new product development (NPD) in high-tech manufacturing small and medium sized enterprises (SMEs). We chose this context because of its knowledge-intensive nature and its high relevance to companies.

In the remaining part of this paper we will explain the research objective and research questions in detail (Section 2), elaborate on the methods and progress (Section 3) and report about preliminary results (Section 4) and short term plans (Section 5).

2 Research objectives

The objective of this research is to create a conditional design theory for the conceptual design (as a product!) of electronic knowledge brokers. The framework of this theory (see Figure 1) is similar to that of a contingency theory, and as such it consists of (1) conditional factors (independent variables), (2) design parameters (dependent variables), (3) archetypical configurations, and (4) potential intermediating variables [Donaldson, 2001; Mintzberg, 1979].

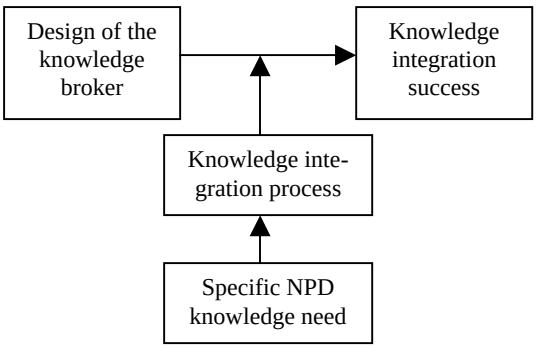

Figure 1. Framework of a Conditional Design Theory for Knowledge Brokers

Figure 1 illustrates our argument that the success of a knowledge broker design in terms of successful KI, is conditional upon the KI process, which is on its turn conditional upon a specific knowledge need. Objective of the research is to specify and refine this framework.

Since it includes the KI process as collection of intermediating variables, an important element of the theory is a model of the KI process. Such a model is desirable to map the effect of specific knowledge needs on this process. After an extensive review of current literature (see below) we did however not find such a model. Therefore, the development of a KI process model was included in our research questions:

1. What general, relevant and valid conceptual process model can be derived from the current theoretical understanding of knowledge integration?
2. What relevant conditional factors, design parameters and configurations of electronic knowledge brokers can be extracted from theory and practice?
3. What is the quality of the developed conditional design theory in terms of reliability, validity, and practicality?

By answering RQ1 and 2, the theory is developed. RQ2 asks for explication of requirements for knowledge brokers. These will be derived from a definition of KI success, because in our research the main requirement of a knowledge broker is that it leads to successful KI. In RQ3 the developed theory is confronted with practice and tested on reliability, validity, and practicality [cf. Cooper & Schindler, 1998].

3 Method and Progress

This section briefly discusses the methods used to answer these research questions (Section 3.1) and progress that has been made so far (Section 3.2).

3.1 Method

The first research question is answered by doing an extensive review on the literature on KI, followed by qualitative and quantitative empirical research. Because interpretations of KI in the current literature [including Grant, 1996; Leonard-Barton, 1995; Szulanski, 1996] are narrow compared to our interpretation, we review not only literature on KI, but on environmental scanning, information seeking, boundary spanning, technology transfer, interorganizational knowledge sharing, absorptive capacity, organizational learning and knowledge management as well. From this review an analytical process model is derived, consisting of a number of activities within each of the three stages of identification, acquisition and utilization.

We chose to create a *general* and simple model containing the smallest set of autonomous activities that is able to cover the variety of KI in the reviewed literature. Since a model cannot be general, simple and accurate simultaneously [Thorngate, 1976], this choice implies a loss of accuracy.

Such a model is *relevant* for creating a contingency theory because it consists of several autonomous components that serve as intermediate variables within the theory.

To judge the *validity* of the model, a number of qualitative semi-structured interviews and a quantitative survey amongst NPD managers of 1700 high-tech manufacturing SMEs in Germany, Israel, the Netherlands and Spain are done. Four national random samples are created, stratified in four size classes (2-9, 10-49, 50-99 and 100-499 employees). ISIC Rev 3 codes are used to select high-tech industries, based on average R&D expenditure.

To answer RQ2, we start with a review of the literature on brokerage. Since we found only very few contributions that address the design of electronic *knowledge* brokers [Rose, 1999; Vishik & Whinston, 1999], we review literature on technology, network, information, and market brokerage as well. From this literature we extract the elements of our design theory

In parallel to the literature review, an exploratory evaluation of existing electronic technology brokers is done to find additional information on these elements. Examples of such websites are irc.cordis.lu, www.jbhelpme.com, and www.clusterlink.com.

Moreover, the results of the empirical study in RQ1 lead to insights in the design elements as well. The qualitative part provides in depth information about different appearances of the KI process in practice and the quantitative part allows for exploring conditional factors by analysis of variance and path analysis.

As a result of these parallel tracks, a draft conditional design theory on electronic knowledge brokers is developed.

In RQ3, this draft theory is tested on reliability, validity and practicality in a number of case studies. Cases are selected that are in line with the developed theory and that are in conflict with it. To exclude interfering factors as screen layouts, cases preferably contain elements that are in contrast *and* that are in line with the theory. In this way, the theory can be tested within a case rather than between cases. We expect that it is relatively easy to find such cases since many current electronic brokers consist of multiple web pages and will not exactly match only one knowledge need or configuration. We expect that they will have elements that are in line with the theory and that are in contrast with it as well.

The cases will be compared and evaluated on their successfulness in supporting the KI process. A simple measurement instrument is developed that measures to what degree users succeeded in reaching their target (e.g. finding certain knowledge) using the concerned web site. Cases will *not* be compared with ways of identifying and acquiring knowledge outside the Internet. Therefore, no conclusions can be drawn about the relative advantage or quality of electronic knowledge brokers in comparison with other types of brokers.

3.2 Progress

The research started in February 2002 and by June 2003 the following progress has been made on the three research questions:

On the first research question, the literature review and development of the conceptual process model was completed in April 2003. In total, 53 international refereed journal articles that contain KI-related models were carefully selected, reviewed and categorized. Based on this review, a paper was written and submitted. In addition to a reflection of the review, that paper contains the conceptual model and propositions for further research.

The data collection for the empirical research for RQ1 has been finished as well. In August and September 2002 we did 33 interviews with NPD managers of 19 companies in Germany, Israel, the Netherlands and Spain. Based on these interviews and a number of expert meetings with scholars and practitioners, a questionnaire was created with mainly multiple-choice questions. This questionnaire was pretested in two rounds at several companies, translated, pretested again and put into an online web survey before January 2003.

In February and March 2003, 1722 randomly selected companies were phoned and asked for cooperation. From these, 416 companies were not reached or turned out not to belong to the target group of high-tech manufacturing SMEs. This lead to an actual sample size of 1306. Companies that initially showed their willingness to cooperate, but did not yet fill out the questionnaire, were reminded twice. In May 2003 the data collection was finished, leading to responses of 317 companies (24.3 %). At the moment of writing this paper, data analysis is being completed.

Progress has been made on RQ2 as well. A review of literature on several types of brokerage has lead to a preliminary specification of the framework in Figure 1. Moreover, a number of exploratory browsing exercises on existing electronic knowledge brokers has lead to valuable insights for refining the theory. At the moment of writing this paper further refinements are made.

On RQ3 limited progress was made yet, except for outlining the case selection and testing procedure as explained above.

4 Preliminary Results

This section reports about preliminary results on the three research questions. Each research question is discussed in one sub section.

4.1 Research Question 1

The conceptual model that was constructed based on the literature review is depicted in Figure 2. In this paper we will only elaborate on it briefly; details can be found in a separate paper on this conceptual model, which is still under review. The activities in the model are defined as follows:

Identification Stage

- *Need identification:* finding out what knowledge a company needs at a certain moment for a particular purpose;
- *Gap analysis:* finding out what knowledge is lacking within a company at a certain moment for a particular purpose;
- *Viewing:* monitoring the environment to detect relevant changes;
- *Searching:* striving towards finding an external source of knowledge;
- *Finding:* identifying an external source of knowledge. This can be personal (e.g. suppliers) or impersonal sources (e.g. magazines).

Acquisition Stage

- *Transaction:* a transfer of a good or service across a technologically separable interface;
- *Communication:* a transmission of a message by a source to a receiver(s) with conscious intent to affect the latter's behavior;
- *Cooperation:* an activity in which two or more participants work together for at least one common end;
- *Imitation:* reproducing knowledge by copying objects/events from a source with or without its assent;
- *Appropriation:* acquisition of the property rights of the acquired knowledge.

Utilization Stage

- *Direction:* codifying tacit knowledge into explicit rules and instructions;
- *Routinization:* development of a fixed response to a defined stimuli;
- *Diffusion:* store and disseminate knowledge throughout (part of) the organization;
- *Application:* use of the knowledge for the purpose it was acquired for;
- *Exploitation:* reuse and recombination of knowledge for other purposes than the original purpose.

In addition to these 15 activities, two decision points are included in the model. After identifying the needed knowledge, a company will decide on whether to acquire the knowledge or not. In some cases the acquired knowledge is utilized in the organization without further consideration. However, since knowledge is to a large extent an experience good [Shapiro & Varian, 1999; Wijnhoven, 2002], valuation of the knowledge can often only take place after acquisition. Therefore, a second decision point (decision to apply) is not trivial.

The second part of the answer to RQ1 consists of an empirical study. Although the data analysis of the quantitative part of this study is not finished, the most relevant results are summarized as follows:

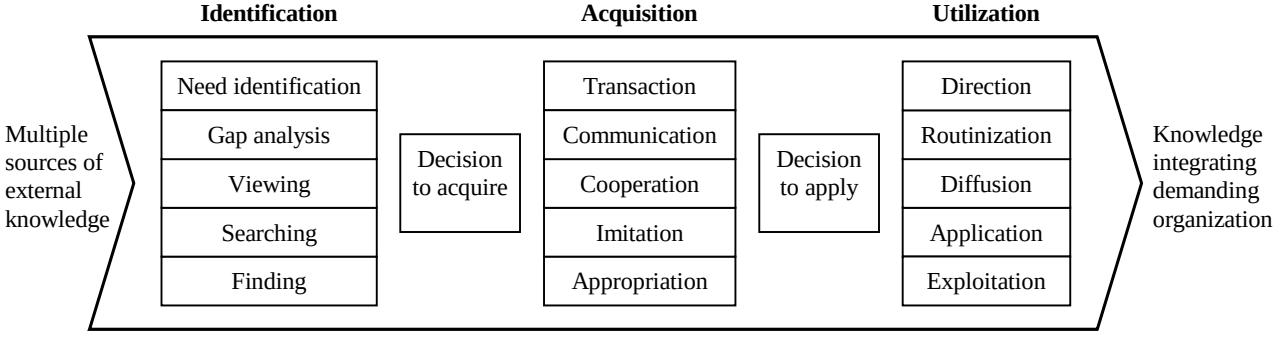

Figure 2: Analytical Process Model of Knowledge Integration

- Customers, suppliers and fairs/trade shows are the most important sources for knowledge about customers/markets and knowledge about technology;
- Companies depend on external knowledge throughout the NPD process;
- Companies get most of their NPD knowledge from other countries;
- Companies express a need for more structure in their searching activities and complain that they look in too many places to find knowledge they need;
- Imitation (i.e. by analyzing products) is reported to be the most frequently used way of acquisition;
- Companies store and disseminate the acquired knowledge for reuse but only reuse it infrequently;
- On average companies use a considerable amount of software (4.4 out of 17 software categories) and methods (5.7 out of 15), during KI, but only general ones. Specific methods and software are hardly used.
- There is no single stage that is significantly more difficult than the other two stages;
- There are virtually no significant differences (at $p = 0.05$) in the way companies execute the three stages and in the degree to which they succeed in this between companies of different sizes, ages and branches of industry;
- There are significant differences between countries;
- The conceptual model is able to model the empirical variety of the KI process;
- The KI process is *not* easily recognizable for practitioners because it is not a primary process.

With finalizing the data analysis, the first research question will be answered in the near future.

4.2 Research Question 2

On the second research question, preliminary conditional factors and design parameters have been identified.

As Figure 1 shows, we distinguish only one conditional factor in our model: knowledge needs. In contingency theory, multiple factors are included, like company size, age, environmental stability, and complexity. We posit that for the knowledge integration process these factors are however not contingency factors but antecedents of them, in that knowledge needs are determined by these factors. For example companies in a simple and stable environment will need other knowledge than companies in a complex and dynamic environment. Because we aim at a conditional theory of knowledge brokers and not of knowledge needs, we do not include these antecedents in our research. Moreover, both our empirical study as research by Hargadon [1998] shows that at least some of these factors (age size, and branch of industry) are non-significant regarding the way companies search for knowledge.

To arrive at a limited set of 'knowledge need categories' we ground on literature on information seeking and on literature on NPD. The first offers abstract categories of information needs [Choo, Detlor, & Turnbull, 2000; Dervin, 1992; MacMullin & Taylor, 1984]; the second offers specific categories of knowledge needed during NPD or innovation [Faulkner & Senker, 1995; Leonard-Barton, 1995; Nelson & Winter, 1982]. At the moment of writing this paper, no final choice for one or combinations of these options was made.

In Figure 1, the KI process was depicted as an intermediating variable, which illustrates our conviction that the course of the (activities and stages within the) KI process is dependent on the knowledge need that initiates it. In Figure 2 we have shown the components of the KI process on which this variance may occur. Since the relations between knowledge needs and the KI process have not been explicated yet, this will be done in the near future.

The next part of the design theory are the design parameters with which the configurations can be constructed. According to Gümbel [1985], intermediaries are specialists in the reduction of transaction costs by providing structural and functional efficiency. Following Gümbel, we distinguish two basic design parameters on which the configurations will vary.

- *Structure:* the position of the broker in relation to a set of sources and recipients that are potentially linked by the broker;
- *Process:* the set of functions that the broker performs to realize the flow from source to recipient.

With structure we do not refer to the internal structure of the broker but to the structure of the network around the broker. This network consists of a cluster of suppliers, a cluster of demanders, and the broker itself. Gümbel identifies three sources of structural efficiency of intermediaries [1985]: increasing volume of transactions, increasing frequency of transactions and decreasing the number of potential contacts (Baligh-Richartz effect). In the current research we only include the Baligh-Richartz effect, because we believe that for a user of a knowledge broker, this source of efficiency is far more relevant than the other two. Companies will use a knowledge broker to ease their search for knowledge, in other words: to reduce the number of sites they have to visit to find their knowledge.

Our basic assumption on this design parameter is that different knowledge needs ask for a different constellation (or clusters) of demanding and supplying parties. For example, for finding a new product idea, a company will benefit from a large, open and heterogeneous set of sources, whilst for finding a particular technical feature of a machine a small, dedicated, and homogeneous group is desirable. Moreover, we assume that the dimensions along which clusters should be created will differ for different knowledge needs. For example, for knowledge on potential markets, a geographical dimension might be relevant because market conditions may differ between countries. For product ideas however, this dimension most probably will not be relevant because ideas might originate from all over the world.

When we observe current knowledge brokers on the Internet, we find large support for the claim that they are structured from a supply perspective. In many cases a number of supplying parties find reasons to make their knowledge accessible on the Internet together.

Some of these reasons are: getting governmental support, located in the same region, and providing the same kind of material (e.g. journals). Unsuccessful examples are Supernet [Bessant, 1999] and Innovatienet. Although these reasons might be fully legitimate for working together, they often do not make much sense from a knowledge integration perspective. As we have indicated above, high-tech SMEs get most of their NPD knowledge from other countries. For this knowledge, a focus on a certain region will not be very useful. Moreover, we assume that SMEs need knowledge on a certain topic and will not much bother from exactly which type of source they get this knowledge. Bundling the supply of journals is probably not the optimal solution in this case. We illustrate this non-optimal way of clustering around knowledge brokers in Figure 3:

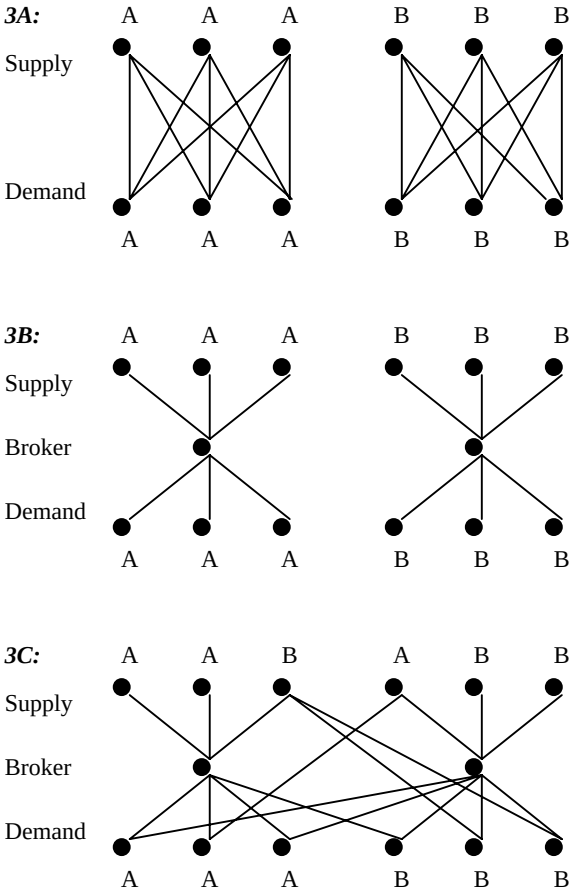

Figure 3: Network without (3A), with Optimally Structured (3B), and with Sub-optimally Structured Broker (3C)

In this figure, there are six suppliers and six demanders on two topics (A and B). In Figure 3A we see a network without a broker in which each demander for knowledge on topic A (B) has (potential) contacts with each supplier on that topic. In our case, this leads to 18 connections. In Figure 3B we find an optimal solution in which two knowledge brokers reduce the number of connections to 12. In this case, the brokers are structured along the right dimensions. In Figure 3C however we find a non-optimal solution of brokers that might be structured right from a certain perspective, but not from a demand perspective. For example: A, A and B in the left side of Figure 3C might be located in the same region but offer knowledge on a different topic.

In Figure 3C, only two suppliers were exchanged, leading to an increase from 12 to 16 connections. It is obvious that connecting more suppliers to a broker wrongly from a demand perspective leads to more (potential) connections.

A second aspect within the design parameter 'structure' is the extent to which supplier, demander and broker belong to the same group. Gould & Fernandez [1989] have distinguished by a formal analysis five types of brokerage relations:

1. *Coordinator* (or local broker): All three actors belong to the same group; the brokerage relation is completely internal to the group.
2. *Itinerant broker* (or cosmopolitan broker): The two principals belong to the same subgroup while the broker belongs to a different group.
3. *Gatekeeper:* Broker and demander belong to the same subgroup while the supplier belongs to a different group. The broker can decide whether or not to grant access to an outsider.
4. *Representative:* Broker and supplier belong to the same subgroup while the demander belongs to a different group. The broker acts as a representative for a fellow party member and attempts to establish contact with an outsider.
5. *Liaison:* Broker, supplier and demander all belong to a different subgroup. The broker's role is to link distinct groups without having prior allegiance to either.

Figure 4 illustrates these five types for a single supplier, demander and broker.

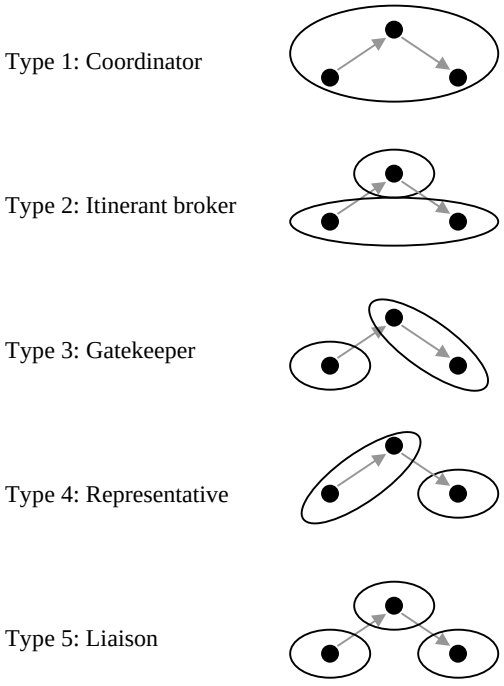

Figure 4. Five Structural Types of Brokerage Relations

Following our theory, each of these types should only be successful when addressed to a certain knowledge need. We find support in Hargadon's work on knowledge brokerage [1998]. According to him, technology brokers that transfer innovative (new product) ideas are most effective when they operate in very different in-

dustries. Therefore, for the knowledge need 'new product ideas' a broker of type 5 (Liaison) will be most effective and types 3 and 4 can be effective as well. An example of a situation in which type 1 would be most effective, stems from the literature on regional clusters [e.g. Darr & Kurtzberg, 2000; Lissoni, 2001]. Because tacit knowledge is difficult to transfer (in particular over the Internet) it is desirable that supplier and demander belong to the same (regional) subgroup.

Although Figure 3 and 4 provide useful insights in the structure as design parameter, they do not yet provide insight on the dimensions on which clusters can (and should) be created. We already mentioned a few of these dimensions (region, source type, industry) but have not created or found a taxonomy or typology of these dimensions yet.

The second design parameter that follows from Gümbel [1985], is 'process'. While a right structure is a prerequisite for creating a *match* of supply and demand, it is not sufficient for creating this match or establishing the *flow* of knowledge from supply to demand. The knowledge broker can execute certain functions to establish the match and flow. In the literature on market brokerage, a number of these functions are mentioned [Bailey & Bakos, 1997; Bakos, 1997; Gümbel, 1985]:

- Searching and matching
- Monitoring and guaranteeing
- Negotiation and contracting

Although these functions have potential added value for knowledge brokers as well, there are two reasons why additional research is needed. First, the current listings of functions/roles of electronic intermediaries are purely based on empirical observations and lack taxonomy. We take the position that for creating a design theory such taxonomy is highly preferable. Second, because these functions are based on market rather than knowledge brokers, additional and/or other functions will be needed. Knowledge is not similar to a product that can easily be sold and distributed, because it can be intangible, embedded in people, and not codified. Moreover, the KI process has similarities with, but is not identical to the purchasing process. Therefore, functions of brokers in both processes will be different. Until now we found only very few contributions on functions for knowledge brokers and these lack taxonomy as well.

After reviewing a number of existing knowledge portals and literature on several types of brokerage, we arrived at the following list of functions:

- *Visualization:* e.g. making visible which actor has knowledge on a certain subject;
- *Structuration:* e.g. structuring of knowledge sources in certain categories;
- *Navigation:* e.g. browsing, searching, crawling;
- *Adaptation:* e.g. changing properties of knowledge, like format, or language;
- *Valuation:* e.g. evaluation of knowledge or of a source of knowledge, guaranteeing;
- *Articulation:* e.g. explicating a need for knowledge;
- *Bridging:* e.g. of time and distance between supplier and demander;
- *Accumulation:* e.g. of a number of sources;
- *Publication:* e.g. making public to other actors;
- *Notification:* e.g. proactively and automatically informing actors about relevant changes;
- *Facilitation:* e.g. facilitating collaboration and communication by a virtual working space.

This (tentative) list indicates that knowledge brokers potentially have many value adding functions for their users. We expect that the final list will be longer and hope to find a way to arrive at a taxonomy.

4.3 Research Question 3

We made not much progress yet on RQ3, because it grounds on RQ2, which is not yet answered. By gathering information on a number of existing knowledge brokers (of which some were mentioned earlier in this paper) and by conducting interviews and a questionnaire amongst high-tech SMEs, we have found empirical support for our theory in development. However the amount of empirical data should be significantly increased to enable theory testing. For testing a theory we cannot use the same empirical material as for developing it, since the test would be insignificant. Therefore, RQ3 should not be started before the theory is developed.

5 Further Research

In this final section we will briefly address future plans (Section 5.1) as well as a number of open questions on which still has to be decided (Section 5.2).

5.1 Short Term Plans

At the moment of writing this paper, we are mainly involved in answering RQ2. RQ1 is almost answered and RQ3 is still some time before us. Therefore, short-term plans will mainly refer to RQ2.

In the coming period, the focus of the research will be on the finalization of the design theory. On RQ1 we will complete the data analysis on interviews and the questionnaire to arrive at a general, relevant, and valid KI process model. Data analysis will focus on *how* high-tech SMEs do their KI: when in the NPD process, from which sources, how do they identify, acquire, and utilize knowledge, which tools, methods and techniques do they use, etc.

From the data, useful information for RQ2 can be derived as well. By analysis of variance and path analysis (using LISREL) we will analyze which dimensions are relevant for clustering supply and demand of a broker to fulfill a specific knowledge need. As indicated in Section 4.1, some work on this has already been done. However, additional variables will be included in the analysis.

In addition to this empirical research at users, we will analyze existing knowledge brokers and build further on the structures presented in Figure 3 and 4. Additional literature on brokerage will be used for this as well. From this, we will derive a preliminary theory on the *structural* design parameter.

To arrive at conclusions on the *process* design parameter, the empirical data will be used as well. For that, problems that occur using the Internet during KI, are identified. These problems provide useful insights for the process design parameter of the design theory in that they explicate deficiencies of current knowledge brokers. Next, the list of functions that was presented in Section 4.2 will be transformed to a taxonomy of functions.

In addition to these design parameters, the conditional factor of the design theory (specific knowledge need) needs to be constructed and related to the intermediating factor (KI process). Based on this factor it will be possible to arrive at a number of configurations that will fit a certain knowledge need.

The final element of the theory is a measure of KI success. For this we will use the KI process as it was mentioned in Section 4.1. Success will most likely be defined as satisfaction of the user: did the user identify his needs, did he find what he needed, etc. when he used a certain knowledge broker.

From the several elements in the theory we will derive a number of hypotheses to test the theory. They will have the following format:

> *H: For <this specific knowledge need> a knowledge broker with <this structure> and <these functions> will be most effective for successful KI.*

The measure of success is highly relevant for RQ3. We will test the developed theory in a number of case studies. The object of research in these cases will be the knowledge broker. We will select knowledge brokers that are designed in line with the theory and that are in contrast with the theory. At the moment, we do not think it is feasible to thoroughly test the theory within this PhD research. By using a limited number of cases we will only be able to assess whether the theory is likely to be reliable, valid and practical.

5.2 Open Questions

There are a number of open questions that need to be answered on a short or longer term to be able to continue this research. We formulated the most urgent questions below.

1. *Is it feasible to include three KI stages in this research or should we limit ourselves to one or two?*

First, the utilization stage is not really an interorganizational stage and therefore the added value of a knowledge broker is not obvious. However, it is a very important stage. Second, as far as we know by now, the identification and acquisition stage are to a large extent *independent* of each other and are very different in nature regarding the desirable structure and functions of a portal. Therefore, it might be desirable to limit the research to the identification stage.

2. *Is it feasible to include both structure and process as design parameters or should we limit ourselves to one of these?*

As can be derived from Section 4.2, both structure and process are complex and comprehensive design parameters. It may be infeasible to include them both in this research. In particular the process aspect currently seems to be too comprehensive, considering the large amount of functions. However, both design parameters are highly relevant and interrelated as well.

3. *How to find the dimensions along which knowledge brokers can and should be structured?*

Although it is easy to suggest a number of dimensions on which knowledge brokers can be structured (region, source type, etc.), we did not find a way yet to come to a well founded decision on this. We most likely will need a taxonomy for this to be sure that we included all (relevant) possibilities or have explicit reasons to exclude certain possibilities. Another way to limit the number of dimensions is looking at the structure of existing knowledge brokers. However, since we believe that most of them are not structured from a demand perspective, this might undesirably exclude relevant options.

4. *How to arrive at a limited number of functions and knowledge needs and operationalize them?*

To make the theory practical, we need to narrow down the number of functions and the number of types of knowledge needs to a manageable level. We can choose to be very abstract and define few high-level categories, or to be very concrete and define many specific categories. These choices will have a large effect on the explanatory power of the theory. Therefore a careful decision should be made on this.

5. *How to find suitable cases?*

In Section 5.1 we indicated how we will select cases and that it will be easy to find knowledge brokers. However, for using our success measure, we must contact *users* of a knowledge broker as well, because we want to measure whether they successfully identified and acquired knowledge. Finding such cases with user information will be one of the most challenging tasks for answering RQ3.

In addition to the ex post evaluation of existing knowledge brokers it would also be possible to use the theory in a prescriptive way in an actual design process of a knowledge broker. Since throughput time might exceed the time span of this research, the measurement of success can be difficult for this kind of case. However, it would strongly strengthen our conclusions on the theory if we can test it in this prescriptive way.

6. *Do we need to take into account the suppliers of the knowledge and their interests?*

Since intermediaries typically bridge the gap between suppliers and demanders, one might put forward that needs of suppliers need to be included in the research as well. Suppliers will have reasons to be supply-driven rather than demand-driven and might not be willing to change this. Therefore, the question arises whether it is useful to do research only on the demand side. Although we believe that this can be a useful demarcation *in research*, it is not for the actual design of a knowledge broker.

7. *Which theory is most useful for linking the elements in the design theory?*

Although we have many indications *that* the success of a design of a knowledge portal is conditional upon the

specific knowledge need for which it is used, we do not have a theory yet on *how* it is conditional and *why*. A sound theoretical contribution should contain such an explanation [Whetten, 1989]. Therefore, we will need to answer the question why a certain design is more effective than another design to fulfill a specific knowledge need. Although we could come up with several explanations ourselves, we prefer to base our theory on established existing theories.

These and other questions need to be answered for finalizing the design theory (RQ2) before we can proceed with testing it (RQ3).

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