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DECISION SUPPORT FOR STRATEGIC PARTNER SELECTION IN COLLABORATIVE DESIGN AND INNOVATION

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1. Introduction

The successful implementation of collaborative ventures is a demanding topic for current design research. Conducted research has shown that approximately 50% of all collaborative innovation projects are perceived as failures [Littler *et al.* 1995]. Approaches for improvement through group decision making during the collaborative innovation phase exist [Stacey *et al.* 2000; Zha 2003], the previous phase however, i.e. the set-up and initiation, can be regarded as a rather rarely identified subject in these terms.
There is a variety of research related to generic industry partner selection issues [Cao and Wang 2003; Nijssen *et al*., 2001; Cavusgil and Evirgen 1997], however mainly dealing with theory issues, process definitions and evaluations. However, in many cases the underlying theories are not fully documented or do not necessarily relate to the specific context of *collaborative design and innovation (CDI)*. Additionally, the encountered challenge based on given restrictions significantly differs from these approaches. In this paper we present the adoption of a theory foundation related to CDI success factors into a decision support system (DSS), leveraging an instrument for supporting managers in evaluating potential innovation partners under restricted assessment conditions.

2. The knowledge management challenge

The involved industry partner, an actor in the renewable energy sector, was lacking guidance and support in collaborative innovation planning. In other words, this organization was looking for a strong strategic technology partner for initiating the design and implementation of a new energy technology into a product. As this organization had its core competence more in basic research and technology foundations, the potential partner should provide the product innovation oriented dimension as a required complement.
These potential firms were now to be assessed and benchmarked, however, under the highly restricting condition of *not* contacting any of these potential firms by any means. Furthermore, this industry research had to be conducted under high confidentiality and was not supposed to reach out over any borders others than within small, organisation-internal circles. A few small efforts and mini-projects were started, aiming to collect objective and publicly available information (e.g. Internet sites, annual reports, industry reports) on these potential firms in a structured way, which however failed due to an observed lack of recentness, and especially to the practically non-available access to information on corporate culture. Since this type of hard, fact-oriented information from publicly available sources stood in strong contrast to the internally already available soft information, such as knowledge and impressions among employees on potential industry partner firms, it was decided that these hardly

could be interrelated in terms of decision-making, and therefore at most could be complemented by each other. This soft information, however, still needed to be grasped and quantified in a structured way, which a model had to be developed for.

3. Application of success factors research in collaborative design and innovation

Since the optimization of a collaborative innovation venture has to be conducted and therefore measured based on its success, we need to consider a theory foundation supporting this goal. The determinants of an efficiently and rewardingly implemented innovation cooperation can be put together through examining its success factors.

There exists a variety of research in terms of theories and conceptual approaches for planning, implementation and the assessment of efficient collaborative innovation projects [Kim and Lee 2003]. Among these, however, we chose to select the *strategy-culture-structure (SCS)* based approach [Marxt and Link 2002] due to its simplicity in implementation and its efficiency as shown within previous research projects.

The SCS based approach is an instrument, describing the determinants of collaborative innovation venture management by its three elementary dimensions strategy, culture and structure. If two or more firms intend to initiate an innovation-related collaboration venture, an interfirm fit in all these three categories has to be reached. The main instrumental value provided by this theory concept in terms of implementation approaches is given through the SCS criteria catalogue, representing a checklist covering issues within the three fundamental dimensions.

In its current version, the criteria catalogue consists of 83 criteria issues, which due to their hierarchical structure can be arranged in a tree with a triple layer depth. Within this project, the criteria have been operationalized into questions, allowing us to generate firm profiles by asking managers and decision-makers of the searching firm to work their selves through the catalogue. This SCS profile approach will serve as a fundamental basis for the tool design.

4. The DS4iP concept

Given the industry need as described above, this DSS is constructed in a top-down approach, i.e. instead of designing the DSS first, and successively constructing a usage and eventual coaching process definition, we operated the other way around. More specifically, the challenging industry requirements were used for designing a target process for application of a DSS tool. The DSS tool, in turn, was designed to meet the needs of the target process.

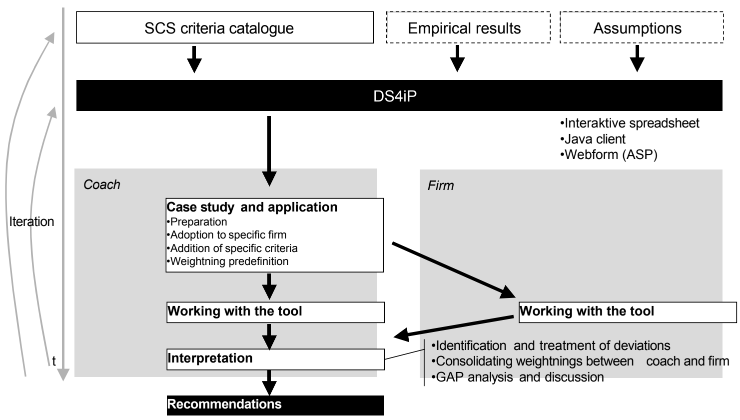

Figure 1. The integrated coaching process

Based on the knowledge management challenge, the internally existing firm knowledge on and about potential partner firms should represent the primary information substance for this DSS. Instead of grasping after publicly available information on a specific firm, the idea is to map the internally existing knowledge among management, employees and other stakeholders inside the system, obviously setting high demands on the firm-internal knowledge management. This additional challenge initiated the idea of conceptualizing the DSS within a larger consulting framework, since external advice for the carrying-out of such a process probably would help to handle this complexity. However, this complexity is expected to pay off in the end, since the involvement of a larger stakeholder group within the searching firm (e.g. all employees) might increase the prospective partner's acceptance internally, once the selection is made and the collaboration is signed.

The *decision support system for strategic innovation partner selection (DS4iP)* is defined as an integrated coaching framework, incorporating the DSS tool into a superordinate process (figure 1). As the concept of the DS4iP tool is to allow the involved decision makers to evaluate or even benchmark potential partner firms autonomously and with instant feedback, its purpose in the end is to result in profiles serving as a basis for discussion. In further versions, DS4iP should be able to incorporate already existing experience in terms of empirical results or assumptions (e.g. concerning nation-specific corporate culture) into the tool, i.e. DS4iP will learn through its iteration. In the current implementation, the DS4iP tool is implemented as an interactive spreadsheet, i.e. a Microsoft Excel sheet with graphical user interface (GUI) objects and macro programming.

Based on the required characteristics of the DS4iP tool, the coaching framework will continue with a partly separated process, implying coach and firm to work with the DS4iP tool in parallel. This parallel profiling process, however, will be preceded by a case study and preparation phase by the coach. In this step, the coach will adopt the DS4iP tool to the current case, i.e. insert data spaces for the firms to be evaluated, enter their names, etc. In further versions, where the DS4iP tool will have learned from its iteration, this phase will become even more important, as industry branch or even firm specific adjustments to the tool will have to be made (e.g. adding specific criteria). Also the weighting of criteria, currently still being fully profiled within the benchmarking process, might in future iterations be preferred as partly predefined or at least suggested.

As a next step, the DS4iP tool will be distributed among the respondents, each of which autonomously work themselves through the tool. The coach(es), representing the external opinion in this process, will work with exactly the same version and respond to all interrogative issues, as far as possible. The key of the DSS is contained within the interpretation phase, where various mathematical mechanisms for comparing, interpreting and illustrating the existing profiles will be needed. The interpretation mechanisms should provide an information basis allowing a broad discussion among coach and firm, especially taking into account occuring deviations in the the benchmark itself as well as in the weightings within the firm and between coach and firm. As far as the interrogative issues related to the SCS criteria are concerned, the interpretation should allow a gap analysis, comparing advantages and disadvantages of given potential partner firms within the SCS criteria catalogue.

As a closing step, the discussion based on the interpretation will be summarized by the coach, resulting in recommendations. Further iterations of this coached partner selection process can be performed either within the firm, e.g. through successively augmenting the respondents group, or through adopting the Delphi method [Dalkey and Helmer 1963]. A wider iteration scope would be defined among several firms, allowing the DS4iP tool to acquire empirical knowledge, e.g. industry branch specific information.

Finally, as far as the integrated process concept is concerned, we appreciate and clearly emphasize the fact that the aim of the DS4iP process cannot be to deliver exact and final decisions regarding the choice of the right partner(s), even if we will model the DSS itself to do so. The DS4iP tool must not by any means be perceived as an oracle, regarding the output generated by its interpretation mechanisms per se. Instead, the focus should be laid onto the co-operative analysis between coach and firm, by letting the generated output stimulate the discussion within the decision process for partner selection.

5. The decision-support concept and mechanism

The DSS tool consists of an electronic questionnaire, i.e. a list of questions, in this context denoted as interrogative issues, related to the respondent's perception of the respective potential partner firm. For each interrogative issue, the following parameters are assessed:

- Perceived overall compatibility of the firm (*beta*); assessed for each potential partner firm
- Perceived relevance of this interrogative issue (r); assessed once for all potential partner firms
- Perceived complexity of this interrogative issue (c)

Based on these initial values, several formal interpretation functions are composed, all of which serve to be combined through superposition (i.e. linear combination). The mathematical compositions of respective interpretations mechanisms will not be further elaborated here. The DSS mechanism can be described in an overview, by illustrating the data flow, the computing functions and the user actions in a simplified process chart (figure 2).

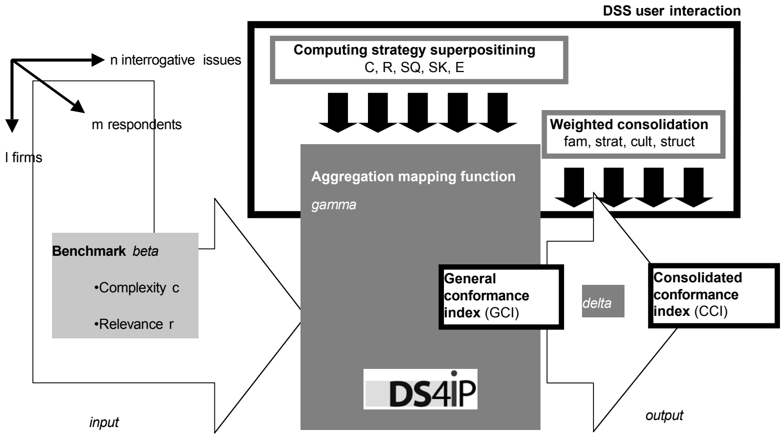

Figure 2. The DSS mechanism

For modeling the mapping function gamma, the influence of the interrogative identifiers on the output benchmark has to be specified. Some identifiers should have positive effect on the output benchmark, whereas others should influence the result in a negative way. The descriptions of the respective influences, representing the basis for elementary computing strategies, as well as their implied benchmark proportionalities and disproportionalities are compiled as follows:

Relevance based (R) computation.

In this computation strategy, the interrogative issues are considered based on their experienced relevance. Based on the idea, that an interrogative issue with high relevance should be considered strongly, we need the output benchmark to grow with augmenting relevance.

Complexity based (C) computation.

Labeling the interrogative issues with respective information on the complexity, i.e. difficulty of the question, allows room for further discussion. However, as we want to model the output to be directly depending on this information, we chose to set this interrogative identifier having disproportional effect on the benchmark output. This is based on the idea that a higher difficulty perceived in answering the question, would imply doubts regarding the benchmark, i.e. lowering the reliability of the answer.

Mean deviation based (SQ) computation.

The SQ-deviation denotes the mean deviation among all parameters. As higher deviation in the answers signifies lower unity within this question, the argumentation based on reliability (similar to previous identifier) motivates disproportionality.

Beta-deviation based (SK) computation.

The SK-deviation denotes the deviation among the compatibility value only. Similarly to previous identifier, disproportionality should be applied.

Hierarchy model consistency based (E) computation.

Given the hieararchy structure of the SCS profile, this concept can be applied for testing one respondent's consistency in terms of questions and related subquestions. Similarly to previous identifier, lower unity within a respondent's answers signifies lower reliability, which leads to disproportionality.

In proportion to the space spanned by n interrogative issues, m respondents and l firms, the collected data consists of three components, i.e. the benchmark value beta, the complexity c and the relevance r. The gamma-function aggregates these values into the general conformance index (GCI), which is controlled by the computing strategies specified by the user, i.e. the balance of R, C, SQ, SK and E.

Finally, the consolidation provided by the delta-function renders the consolidated conformance index (CCI), which again is controlled by the user specified ratio values fam, strat, cult and struct. The values determine the weightings for familiarity, strategic, culture and structural issues, respectively, all of which represent subsets of the SCS profile.

6. Implementation

In our industry application case, as above mentioned consisting of the assistance and the coaching of an actor in the renewable energy sector throughout the collaborative innovation process, the task was to implement the DSS for the initial setting m = 6, l = 2 and n = 83. Dealing with the relatively low complexity due to the low amount of respondents and firms to be benchmarked, it was decided not to implement this version with an advanced programming language and user interface yet. Instead, the implementation was carried out within the spreadsheet and macro programming environment provided by Microsoft Excel, allowing a focus more on the functional modeling and testing in this phase of development.

Using a spreadsheet application for constructing the model, horizontal and vertical sum operations become very convenient to implement. As in this first version of running the DS4iP model, the data consolidation among the low number of respondents also happens manually, all interrogative issues were simply listed into n rows, with m(l + 2) columns. The functions gamma and delta were implemented as macros operating on double float values. Furthermore, as the spreadsheet application allows straightforward composition of graphic output, an interactive cockpit chart summarizing the main outcomes of comparing the two benchmarked firms within the DSS was constructed (figure 3).

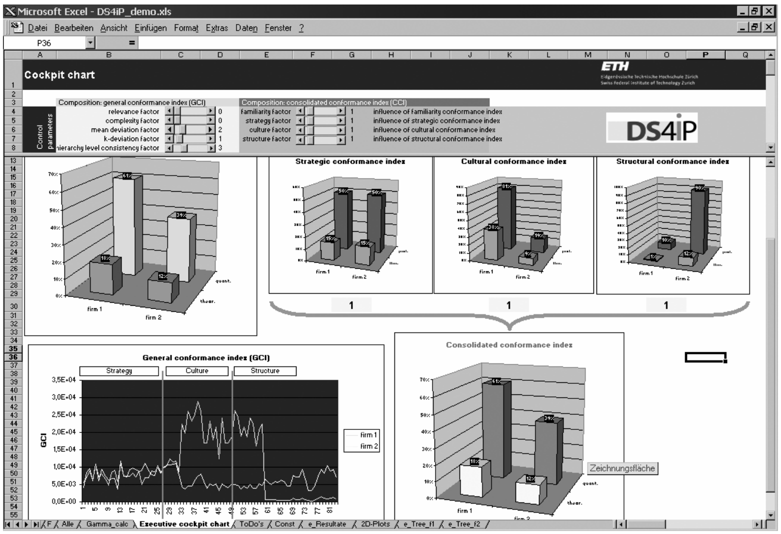

Figure 3. DS4iP cockpit chart

7. Outcomes and discussion

We introduced a definition for a DSS for strategic design and innovation partner selection, taking into account the restricted assessment conditions as implied by the anonymity challenge. We laid special focus on the implementation of the requirements given through the top-down approach. Finally, we demonstrated the implementation within a spreadsheet based software application.

Testing experiences and discussions with our project partner have shown a broad need for simple graphical interpretations, not necessarily containing too much consolidation. We discovered a large interest in by-products such as solely relevance or complexity profiles, i.e. not their respective consolidation within the computing strategies. For further versions of DS4iP, a library of uniform illustration and summarization mechanisms has to be defined.

Since at this premature stage of the DSS life cycle practically no information based on iterations is available yet, this issue has nearly been neglected in the current implementation. For future versions of DS4iP, the process for incorporating such iterative information still has to be designed, allowing the prospective integration of e.g. empirical results or assumptions. Considering the idea of offering

DS4iP also in a standalone version (e.g. web-hosted), functioning without any coach for benchmarking projects of lower magnitude, the set-up of a centrally hosted database for compiling and managing the iterative learning of DS4iP should be considered. Also case specific adoption, e.g. through industry branch-specific criteria, provided by further knowledge on success factors, is an issue which should be covered after further iterations. As far as software issues of the application are concerned, future versions of DS4iP should preferably be implemented in more native programming environments. The option of instant feedback or possibly autonomous firm-internal data consolidation could either be implemented through a distributed system product, or could be supported through a centralized server system as well. Although special emphasis in this project was laid on the coaching process, i.e. the external opinion, as well as the concluding discussion between firm and coach, an autonomous version of DS4iP could still provide a simple and quick tool for managers and decision-makers in grasping firm-internal knowledge about potential design and innovation partners.

Similarly to the superordinate process, integrating the DSS tool into the coaching framework (section 4), this process view of a DSS-supported coaching process will be extended (e.g. by adopting best practices such as defined by [Staudt *et al.* 1992]) towards a holistic definition of an integrated partner selection process, allowing the consideration of even broader interfaces to related knowledge management and knowledge transfer issues.

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