INTERNATIONAL DESIGN CONFERENCE - DESIGN 2016
Dubrovnik - Croatia, May 16 - 19, 2016.

HOW TO IDENTIFY SUITABLE COLLABORATION STRATEGIES FOR OPEN INNOVATION?

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Keywords: open innovation, collaborative design process, collaboration, decision making

1. Introduction

Open Innovation (OI) represents a methodical framework for opening a company's innovation process to allow controlled knowledge exchange with external partners [Chesbrough 2003], [Chesbrough et al. 2006], [Dahlander and Gann 2010]. Besides traditional partners such as suppliers and customers with dyadic forms of collaboration [West et al. 2014], OI also focusses on collaborating with new partners and new types of collaborations such as crowdsourcing with globally distributed users and experts [Möslein and Neyer 2009] as well as with OI-partners from other industries [Echterhoff 2014]. At this, OI stresses the equality of internal and external knowledge for developing potential innovations [Chesbrough 2003]. By using external expertise, OI allows various advantages such as reduced failure rates and shorter time-to-market [Braun 2012]. However, this new openness, new partners and new forms of collaboration also bear new challenges and risks, e.g. knowledge drain, the Not-Invented-Here syndrome and wasted resources due to insufficient OI-outcomes [Enkel 2009].

One central aspect for the success of an OI-project is the selection of relevant OI-partners and suitable forms of involvement [Lopez-Vega et al. 2016] since they are directly linked to various risks [Hyll and Pippel 2015]. Exemplary risks are a bad cost-benefit ratio, knowledge drain and neglecting of strategically important stakeholders, such as decision makers and employees, which might cause other risks like Not-Invented-Here syndrome. Despite this high relevance, methodical support of selecting suitable OI-partners and OI-methods for an OI-project are limited. Usually it is either too abstract for a practical application [Ili 2010] or it focuses on specific types of OI-partners and OI-methods, [Ebner et al. 2009], [Piller and Ihl 2009]. A holistic perspective and approach is missing as analyses of unsuccessful OI-projects show [Guertler et al. 2014]. Such a perspective is crucial due to common shortcomings of trial-and-error applications in industry as well as a majority of approaches from academia, such as (a) neglecting internal OI-partners besides externals, (b) neglecting the strategic-political perspective besides the operative-technical perspective of selecting OI-partners, and (c) neglecting dependencies between potential OI-partners.

Established partial approaches already exist for each aspect, e.g. stakeholder analysis for the strategic partner perspective and Lead-User identification for the operative perspective, but a holistic approach is missing so far. Thus, our research aims at closing this gap by developing an integrated methodology (Figure 2) in cooperation with three German small and medium-sized enterprises (SME). While Guertler et al. [2015a] focus on identifying and assessing potential OI-partners, this paper points out suitable collaboration strategies and methods for OI-partners as well as the preceding ranking and selecting of OI-partners. It establishes the connection to an approach for selecting suitable (operative) OI-methods, which was initially presented by Guertler et al. [2015b]. To support its applicability in industry, the entire methodology is modular, including process decision gates. This allows scaling and adaptations to

the project-specific situation. In addition, a first software demonstrator increases the usability and ensures a consistent data handling.
The resulting research questions for this paper are: How can OI-partners be selected, based on an existing assessment? How can suitable collaboration strategies for each selected OI-partner be derived? How can suitable operative collaboration methods be derived?
Our research design starts by reviewing and analysing different approaches in literature that focus on ranking and selecting (innovation) project partners as well as approaches for selecting general collaboration strategies and operative collaboration methods. We primarily focus on established approaches such as stakeholder analysis [Freeman 1984], [Mitchell et al. 1997], [Bryson 2004], Lead-User identification [von Hippel 1986], [von Hippel et al. 2009] and selection of methods [Birkhofer et al. 2002], [Ponn 2007]. We also consider potential risks resulting from wrong partner involvements, e.g. [Hyll and Pippel 2015] for OI and [Blair et al. 1996] for stakeholder analysis. Combined with our experience from different research projects and the feedback of our three industry partners, we develop a holistic methodology combining a strategic and an operative perspective as well as an internal and external perspective for selecting and involving OI-partners. Our methodology is initially evaluated with the three industry partners within a two-year research project. The evaluation proves the benefit of our methodology but at the same time reveals points for further improvements as well as general success factors and barriers of applying new methods in industry.

2. Theoretical background: identifying suitable collaboration strategies and methods

In the following, we consider "OI-partners" as actors that are operatively or strategically involved in an OI-project. They comprise existing stakeholders and new potential OI-partners that were specifically identified for the particular OI-project.

2.1 Stakeholder theory for deriving collaboration strategies

Freeman [1984] defines stakeholders as "any group or individual who can affect or is affected by the achievement of the firm's objectives". Stakeholder analysis is an established approach from project management mainly in the context of policy making, e.g. [Varvasovszky and Brugha 2000], [Bryson 2004]. It focusses on actors who are essential and critical for the success of a project from a strategic-political point of view. Over the years, a variety of stakeholder processes has emerged, which sometimes build upon each other but in other cases may be less connected. In the following, we present selected stakeholder processes that address ranking, selecting and involving stakeholders.
Vos and Achterkamp [2004] roughly differentiate passive and active stakeholders as well as three possible project roles: problem solvers, developers, knowledge exploitation. However, they do not provide a more detailed support.
Mitchell et al. [1997] use three criteria to assess stakeholders. "Power" describes the influence of a stakeholder on the project or company, "urgency" indicates the immediate need to react to a stakeholder's claims, and "legitimacy" specifies if a stakeholder is entitled to make his claims. The criteria are assessed binary and allow the derivation of seven stakeholder classes and one non-stakeholder class with corresponding generic involvement strategies.
Freeman [1984, p.132] was one of the first who used portfolios for ranking and selecting stakeholders. He assesses stakeholders regarding their "relative cooperation potential" (i.e. the expected likeliness of changing to more supportive behaviour) and their "relative competitive threat" (i.e. the likeliness of risks and actions to harm the project or company). The resulting portfolio structures stakeholders into four categories including generic cooperation strategies: purposefully involving "swing stakeholders", keeping off "defensive stakeholders", always involving "offensive stakeholders" and not involving "hold stakeholders".
Bryson [2004] does not provide a consistent process but a set of different methods for identifying, analysing and documenting stakeholders. He assesses stakeholders regarding three criteria: their level of interest in a project or topic, their supportive or opponent attitude towards the project, and their power. By the "participation planning matrix", he provides a tool for planning the involvement of stakeholders. Possible strategies are to: inform (just providing information), consult (irregular feedback possibilities),

involve (continuous feedback possibilities), collaborate (part of the team), and empower (acts as decision-maker). However, the allocation of stakeholders to involvement strategies is done discursively and a methodical approach is missing.
Ballejos and Montagna [2008] present the "influence and interest matrix" as rudimentary tool for assessing the relevance of stakeholders. The criteria "influence" and "interest" are assessed by a two-step scale (low, high) and allow a structuring into four stakeholder categories and involvement strategies. He also suggests the utilisation of project roles, which comprise specific functions and responsibilities within the project such as beneficiaries, decision makers and experts. When selecting the project partners, all project roles need to be fulfilled. One partner can fulfil several roles and vice versa, which allows a kind of partner optimisation.
Karlsen [2002], based on the work of Savage et al. [1991], uses "collaborative potential" and "potential to affect the project" (corresponds to "power") to assess stakeholders as well as to derive four stakeholder classes with specific involvement strategies: involving "supportive stakeholders", collaborate with "mixed-blessing stakeholders", defend against "non-supportive stakeholders", and monitor "marginal stakeholders".
Varvasovszky and Brugha [2000] and Blair et al. [1996] analysed the previous stakeholder and involvement strategies in more detail - in particular different fits if stakeholders were involved by another strategy than the recommended one. They differentiate three cases: sub-optimal fit with missed opportunities due to too restrictive strategies, sub-optimal fit with waste of resources due to stakeholders not delivering the expected benefit, and a critical fit which endangers a project.
Hyll and Pippel [2015] specifically analyse risks and their links to different partners in open R&D collaborations. Although their work is an important contribution to more successful OI collaborations, the significance is limited due to limited panel data and a lack of empirical in-depth analyses.

2.2 Selecting operative collaboration methods

On the level of operative collaboration methods, there are different approaches for selecting methods (cf. [Guertler et al. 2015b]). Basis for a majority of these selection approaches is the utilisation of method profiles. They characterise methods by several attributes such as purpose, input, output and necessary resources. For instance in the area of product development [Birkhofer et al. 2002], [Ponn 2007], [Lindemann 2009] propose different method profiles. von Saucken et al. [2015] present an OI-specific method profile which comprises a descriptive section for a discursive selection as well as a characteristic section with distinctive attributes for an automated tool-based selection, as shown in Figure 1.
Besides other approaches presented by Guertler et al. [2015b], table-based selection approaches like [Rothe et al. 2014] allow to consider a larger variety of different selection criteria. All methods are assessed regarding the fulfilment of each attribute. For selecting a method, the user weights each attribute regarding its specific relevance for the OI-project. By multiplying and summing up all criteria's weights and specifications, a method ranking is derived.

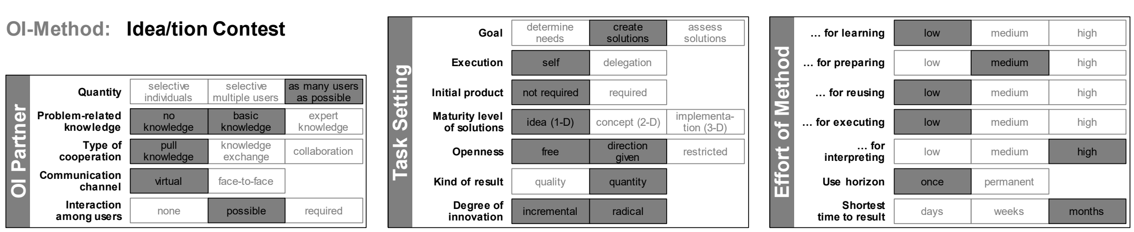

Figure 1. Operative OI-method profile (characteristics section)

Within this paper, we focus on a matrix-based selection approach. While table-based approaches directly map the user input onto method profiles, matrix-based approaches decouple them by using an intermediate mapping matrix [Guertler et al. 2015b]. This allows to add new methods later easily.

3. Methodical framework: Situative Open Innovation

To address the relevance of systematic planning of OI-projects and the lack of corresponding methodical support, we developed the "Situative Open Innovation" (SOI) methodology [Guertler et al. 2015a]. It supports OI-teams in systematically planning OI-projects from analysing the project's context ("OI-situation"), identifying and selecting relevant OI-partners, deriving suitable involvement strategies and collaboration methods as focused here, as well as planning the project controlling and risk management. The selection of OI-partners and collaboration methods are closely linked.

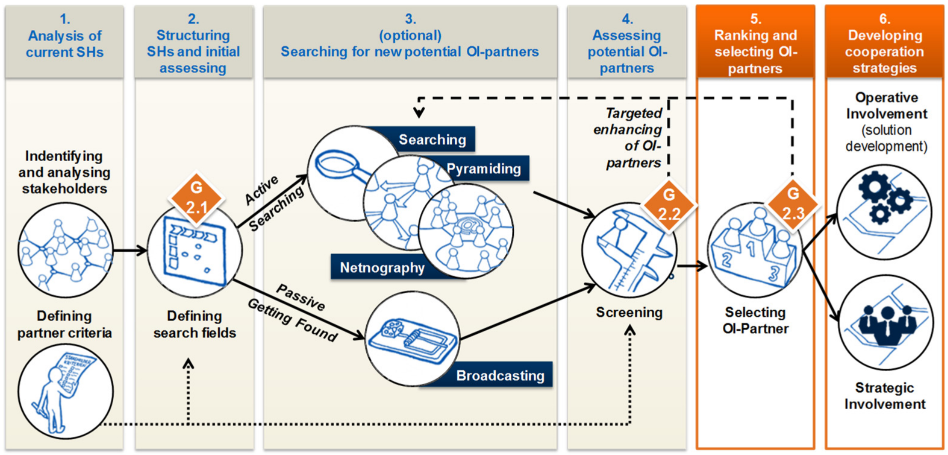

Figure 2. Situative Open Innovation: selecting relevant OI-partners - focussing on ranking and selecting OI-partners and collaboration strategies

As depicted in Figure 2, the OI-partner selection process comprises six steps [Guertler et al. 2015a]: (1) identification of existing stakeholders and dependencies, (2) initial assessment and structuring of these stakeholders to derive search fields for searching for new OI-partners, (3) search for new OI-partners, and (4) detailed analysis of potential OI-partners based on operative-technical (e.g. specific technical expertise or software skills) and strategic (e.g. power, interests and attitude towards the OI-project) partner-criteria. In addition, they can be weighted according to their project relevance). In (5) a multi-perspective ranking and selection of OI-partners is derived as a basis for the (6) derivation of specific involvement strategies and collaboration methods. We differentiate two major involvement strategies: (a) an operative involvement for developing a solution for the OI-project's goal, and (b) a strategic involvement to ensure the success of the OI-project from a (company-) political perspective. This paper focuses on step (5) and (6), which are explained in more detail in the following.

3.1 Ranking and selecting relevant OI-partners

This step provides a multi-perspective presentation of the previously assessed stakeholders / potential OI-partners. It ranks potential OI-partners according to different dimensions (such as strategic relevance, operative potential, structural and political influence) and supports an OI-team in reflecting different (project-specifically relevant) perspectives when selecting OI-partners. At the moment, SOI offers three portfolio rankings originating from different research areas, as depicted in Figure 3.

3.1.1 Strategic-Operative Portfolio

Basis of this portfolio are the assessment of potential OI-partners regarding operative-technical and strategic-political partner selection criteria as well as the analysis of dependencies between stakeholders/ potential OI-partners. Using a weighted and standardised sum of all operative-technical criteria, the operative-technical potential of each OI-partner can be derived on the x-axis - analogously their strategic relevance on the y-axis [Guertler 2014]. In general, potential OI-partners are more relevant for an OI-project the more to the upper right corner of the portfolio they are located. Furthermore, the portfolio supports in identifying critical dependencies between stakeholders, which might endanger the OI-project.

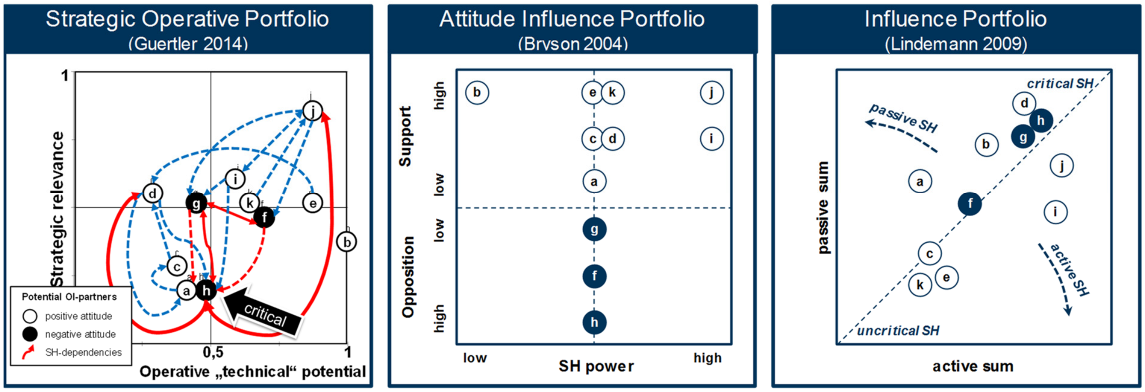

Figure 3. SOI: three ranking perspectives of potential OI-partners

3.1.2 Influence Portfolio

This portfolio is based on a method presented by Lindemann [2009] from the area of product development and complexity management. Based on the analysis of dependencies between stakeholders, the active sum and passive sum of each stakeholder is calculated. The active sum on the x-axis describe the number of stakeholders influenced by a specific stakeholder, while the passive sum on the y-axis comprises the number of stakeholders that influence him. The "activity" metric as quotient of active and passive sum indicate if a stakeholder influences more than he is influenced or the other way round. The "criticality" metric evaluates a stakeholder's level of connectivity to other stakeholders. In general, the more active a stakeholder the higher his relevance to the OI-project due to his high relative influence. Furthermore, the higher his criticality the higher his relevance due to his high level of interconnectivity.

3.1.3 Interest/Attitude-Influence Portfolio

Bryson [2004] suggested to structure stakeholders according to their influence/power and their attitude, i.e. their level of interest and if they are in support or opposition to the project. In general, an OI-team should primarily aim at involving the most powerful supporters, and convincing or weakening the most powerful opponents, as well as secondarily strengthening weak supporters.

3.2 Deriving suitable collaboration strategies

Figure 4 shows a more detailed representation of the strategic-operative portfolio. It allows to derive generic involvement strategies, which can be specified in the following steps. Potential OI-partners at the right hand side of the portfolio show a high technical potential, while potential OI-partners at the upper part comprise a high strategic relevance for the OI-project's success. Based on a partner's location in the portfolio the following generic involvement strategies are possible: (Q1) a strategic involvement for the upper left part due to the specific high strategic relevance but low operative potential; (Q2) an operative involvement due to the high operative potential, because of their high strategic relevance, these are primary OI-partners; (Q3) an operative involvement: due to a lower strategic relevance, these stakeholders usually play a supportive role (e.g. cross-industry experts); and (Q4) a non-involvement for the lower left part due to the lack of both strategic relevance and operative potential. However, to avoid subsequent collaboration barriers and risks, it is necessary to consider dependencies between stakeholders / potential OI-partners. Dependencies can support positive behaviour of stakeholders as well as negatively affect attitude and motivation of stakeholders.

In the industry example in Figure 4 (cf. [Guertler 2014]), stakeholders with a positive attitude towards the OI-project are marked by white circles, while a negative attitude is highlighted in black. In this case, stakeholder "d" should be involved strategically. "j" would be a primary OI-partner due to his high strategic relevance and high operative potential. "a", "c" and the negative "h" could be neglected due to their low OI-project relevance. However, as the dependency analysis reveals, there is a strong bidirectional dependency between the negative "h" and the potential OI-partner "j". Without a detailed analysis and consideration, this dependency might endanger the OI-project's success. There are three generic strategies how to deal with those dependency situations: (a) cutting the connection between "h" and "j"; (b) convincing and involving "h"; and (c) not involving "j" but e.g. "e".

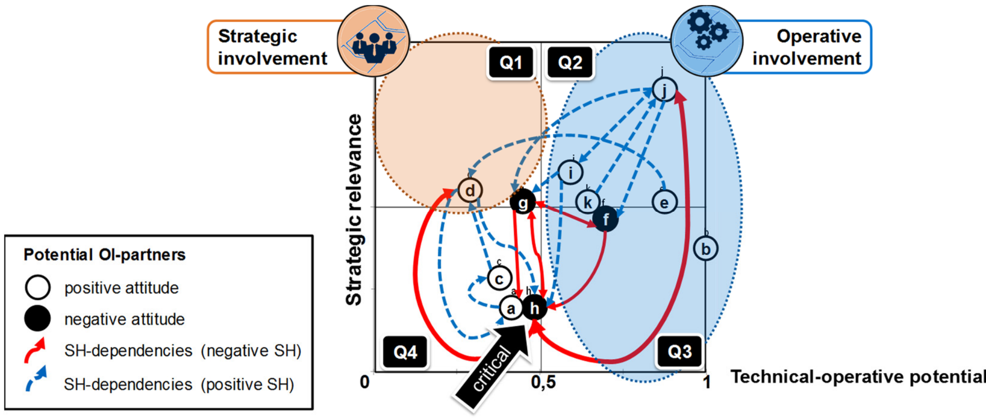

Figure 4. Strategic-Operative Portfolio for selecting OI-partners and collaboration strategies

To support selecting the right strategy, the Influence Portfolio and Attitude-Influence Portfolio can be utilised. The Attitude-Influence Portfolio indicates the intensity of support or opposition as well as the influence onto the OI-project. The Influence Portfolio evaluates stakeholders' influence and dependencies from a network perspective. For instance, if the opposition of "h" is low, strategy (b) might be the option of choice. Whereas if the opposition and influence of "h" are high as well as the dependency between him and "j", strategy (c) might be better suitable.

3.2.1 Selecting suitable strategic involvement strategies

The Attitude-Influence Portfolio supports to identify the most powerful supporters to involve them as well as the most powerful opponents to be considered. In addition, the Influence Portfolio indicates active and critical stakeholders from a network perspective that are highly influential and connected, and should be involved in the OI-project as promoters. The portfolios of Freeman [1984] and Savage et al. [1991], also support to derive suitable approaches of strategic involvement.

3.2.2 Selecting suitable OI-methods

For an operative involvement, it is important to select a suitable OI-method. Since OI-methods can be distinctively characterised by method profiles, a tool-based selection process is possible. Figure 5 illustrates the basic structure of the OI-method selection tool. As initially described by Guertler et al. [2015b], within the tool, OI-methods are stored as method vectors according to their method profiles (Figure 1), (cf. [von Saucken et al. 2015]). Thus, new OI-methods can easily be added at a later date.

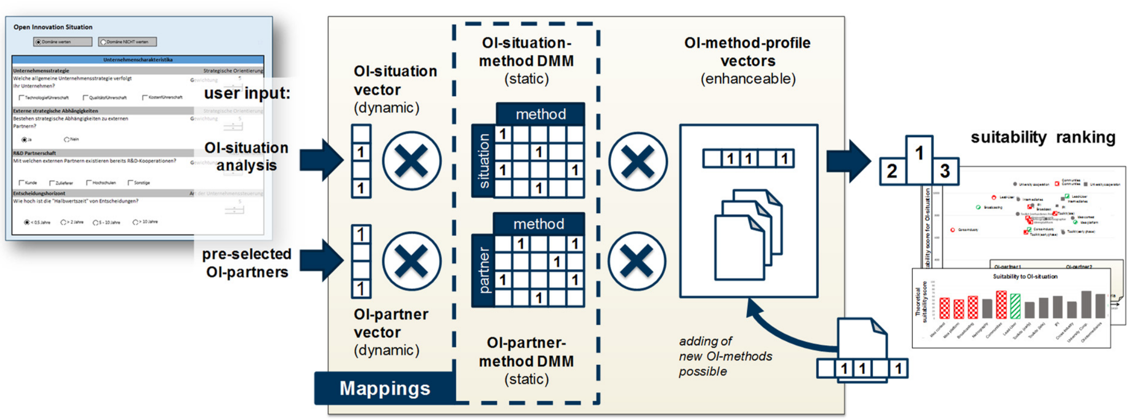

Figure 5. Structure of operative OI-method selection tool

The user input, which describes the OI-project and OI-partners, is also handled as a vector. The input can be differentiated in the OI-situation that is characterised by criteria such as project budget and need for concealment, and up to five potential OI-partners that were derived from the Strategic-Operative Portfolio. They can be characterised by criteria such as number of included individuals and location. The mapping between situation criteria, partner criteria and method criteria is realised by a Domain Mapping Matrix (DMM) [Danilovic and Browning 2007]. Hereby, these criteria are mapped to each other independently from specific OI-methods to allow a later expandability. In addition, for each OI-method specific "trigger" criteria that recommend the application of an OI-method, and "KO" criteria that indicate potential barriers for applying an OI-method are defined.
For utilising the tool, the user fills a questionnaire in MS Excel. The input is stored as vectors (for details see [Guertler et al. 2015b]). These input vectors of situation and partners are multiplied with the DMM. By multiplying the resulting intermediate vector with the OI-method vectors, the scalar products represent the corresponding ranking scores of each OI-method. The ranking scores are depicted in two ways, as shown in Figure 6. A one-dimensional ranking presents the total score of each OI-method. A two-dimensional portfolio ranking allows a more detailed ranking differentiated into suitability for the OI-situation at the y-axis and the suitability for up to five potential OI-partners at the x-axis. As Figure 6 illustrates, each partner-method combination is represented by one dot. All dots of one specific OI-method are at the same (situation) y-position while their x-position varies depending on the corresponding OI-partner. This allows to identify the best OI-partner-method combination for a given OI-situation.

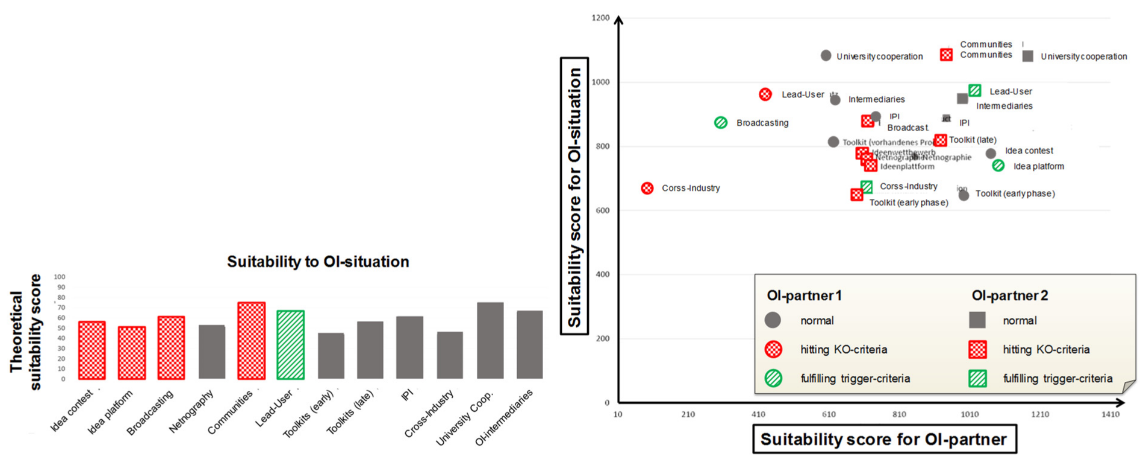

Figure 6. One-dimensional (l) and two-dimensional (r) ranking of suitable OI-methods

OI-partner-method combinations are highlighted in green if they fulfil specific trigger criteria or in red in case of KO criteria, e.g. a high need of concealment would be a KO criterion for ideation contests while a large size of the OI-partner group would be a trigger criterion.
A subsequent discussion of the ranking results within the OI-team is crucial since each OI-project is unique and might have context factors that massively affect the suitability of specific OI-methods. The OI-team also needs to evaluate trigger and KO criteria if e.g. KO criteria could be avoided by method adaptions or if the regarding OI-method needs to be excluded.
To support usability, the OI-method selection approach was implemented within an MS Excel tool.

4. Case-study-based evaluation in industry

The overall methodology for planning OI-projects and selecting OI-partners was developed and evaluated in the context of a two-year research project with three SME partners from the area of machinery and plant engineering. Since the project is still ongoing, within this paper we present the evaluation with one of the companies, which has already been completed. The company was supported by searching for and assessing potential OI-partners. The selection itself was independently done by the company. In parallel, we derived an involvement ranking based on our methodology. This allowed to

compare our methodical ranking with the company's selections regarding commonalities and differences.
The company is a manufacturer of mechatronic facility technologies that show a high amount of mechanical parts. The goal of the OI-project was the development of a mechanical solution for a decades-old problem since previous collaborations with suppliers and others had not been successful to solve the problem. Thus, the OI-project was aiming for new hitherto unknown OI-partners. Hence, "newness to company" was one important criterion of exclusion for partner selection. Operative-technical partner criteria were e.g. product knowledge, experience with the product's material and its dynamic behaviour. Strategic-political criteria were traditional stakeholder criteria.
The evaluation revealed that in this case a holistic assessment in terms of the Strategic-Operative Portfolio was not possible. On one hand, existing stakeholders were relatively well assessable due to available information and experience with them. However, due to the criterion of exclusion (newness to company), they were excluded for an operative involvement and were only considered for a strategic one. On the other hand, new potential OI-partners were difficult to assess due to a lack of access to reliable information. While an evaluation of their operative-technical potential was possible, the strategic perspective could not be analysed. Thus, they were only considered for an operative involvement.
Based on our methodology, we identified the following stakeholders for strategic involvement: management of development department, company management, responsible development department, regulators, industry association, operations scheduling department, three suppliers, B2B customer B, quality management, internal certification department and B2C customer C (product testers). The company selected the legal department (e.g. NDAs for operative collaboration), advanced development department, responsible development department, management of development department, purchasing department, operations scheduling department and sales department as well as production and quality management department (for a later realisation of the OI-project's results). For evaluating the operative-technical potential of new OI-partners, the company utilised our assessment scheme (weighted criteria analysis) and selected the OI-partners according to the ranking. They only replaced the fifth ranked by the sixth ranked partner due to its more interesting R&D activities.

5. Discussion

The results of the OI-partner selection of our methodology and of the company, coincide for the following OI-partners: responsible development department and its management (as context of the OI-project), operations scheduling department (ensuring the later manufacturability), quality management department (developing internal quality norms and controlling) and company management (approving the budget of collaborating with OI-partners).
However, the results show some differences: on the one hand, the methodology additionally suggested regulators and industry associations as well as specific suppliers and customers. Possible reasons might be that all of them are important from a long-term perspective and by setting the frame of the company's products but were not relevant from a short-term project's perspective. On the other hand, the company additionally involved the legal department (NDAs for operative collaboration), advance development department, purchasing department and sales department as well as production department. At this point, we need to analyse the underlying reasons for these differences in more detail, e.g. type of criteria or their weighting and assessment.
A main challenge was the access to reliable information to assess stakeholders / potential OI-partners. While existing stakeholder are assessable relatively well, there is a lack of information to evaluate new, hitherto often unknown potential OI-partners. While the corresponding assessment of operative-technical criteria is quite challenging, the analysis of strategic criteria is often not possible. This results in an incomplete partner assessment in terms of the Strategic-Operative Portfolio. However, we believe that this is acceptable here since the strategic evaluation aims at reducing the risk of missing important stakeholders. New potential partners are usually not connected to the company in the beginning. Nevertheless, there still remains the need to exploit alternative sources of information such as patent or social media big data analyses.

6. Conclusion

Our approach combines elements from different approaches, such as stakeholder analysis, Lead-User identification and Systems Engineering, to provide multi-perspective rankings when selecting OI-partners. Along with this, our methodology also allows to derive suitable involvement strategies and collaboration methods. Academia benefit by valuable insights of how to combine elements from these different approaches to a holistic assessment methodology. This methodology can also be used for own OI-projects or as basis for further research.

Companies will benefit from our methodology by a systematic process for selecting relevant OI-partners and involvement strategies in order to avoid typical risks resulting from trial-and-error approaches, such as knowledge drain, Not-Invented-Here syndrome and bad cost-benefit ratios. Due to its modular setup, our methodology can be scaled and adapted to the specific project situation, which reduces the effort and increases the applicability. Nevertheless, unexperienced users get a step-by-step guideline that guides them through the process of OI-partner selection and highlights potential points for adaptations. The multi-perspective presentation of results provides decision support in different project situations. By implementing the methodology as software demonstrator, its usability and a consistent data handling could be increased. Besides the possibility of autonomously planning OI-projects, companies also benefit by a better understanding of service offers of external consultants or intermediaries.

However, our approach also shows some limitations. Access to reliable information for assessing potential OI-partners is still one of the major challenges. In particular, newly identified OI-partners are difficult to assess properly. In addition to the derivation of suitable collaboration strategies, in future research, it is also essential to address appropriate acquisition and incentive strategies for different OI-partners as well as measures to establish trustful relationships. In respect to the OI-method selection methodology (and tool), some OI-methods are relatively similar, such as ideation contest and platform, and could be consolidated. In return, new alternative OI-methods can be added, such as maker spaces and crowdfunding.

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