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Situational Open Innovation
Enabling Boundary-Spanning Collaboration in Small and Medium-sized Enterprises

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This dissertation contains small-sized illustrations. For the magnification of details, the author refers to the digitally published version of this dissertation on mediaTUM (https://mediatum.ub.tum.de), the media server of the Technical University of Munich.

Foreword by the Supervisor

Problem

Small and Medium-sized Enterprises (SMEs) are important for a nation's industry and economy since they comprise the majority of all employees along with highly innovative products. Nevertheless, SMEs face several challenges, such as increasing global competition, dynamically changing and more individual customer needs in addition to a regional shortage of skilled workers. Cooperation with external partners is a central success factor for dealing with these challenges and strengthening the innovativeness of SMEs. In this respect, Open Innovation (OI) is a relatively new holistic innovation framework to structure and manage different types of cooperation. On the one hand, OI directly links to established approaches, such as distributed product development, systems engineering and user innovation. On the other hand, OI also comprises new elements such as new partners (for instance, cross industry experts and large crowds) and new collaboration methods, which extend the scope of traditional dyadic collaborations. From an outside-in perspective, OI allows the utilisation of external expertise and offers various benefits, such as a shortened time-to-market and more innovative products.

However, the application of OI is not trivial and involves challenges for companies, which can overwhelm SMEs in particular. On the one hand, they might cause application mistakes, which can result in wasted resources or even project failures. On the other hand, overstated fear of OI can hinder its use and lead to missed opportunities. Therefore, SMEs need to be supported in planning and executing OI systematically, to exploit its entire benefits.

Objectives

The overall goal of this dissertation is the development of a methodical and prescriptive guideline (so called planning methodology), which enables SMEs to autonomously plan OI projects as well as in profoundly evaluate service offers of external intermediaries. The guideline shall (a) provide prescriptive support in operatively planning an OI project, (b) be holistic by considering different OI partners and OI methods, and (c) be adaptable to different company and project contexts.

Results

The main outcome of this dissertation is a modular and scalable methodology (methodical guideline). It can be adapted and used in different contexts as the evaluation in industry proved. The guideline supports SMEs in systematically analysing the goal, relevant boundary conditions and constraints of the OI project. Subsequently, existing stakeholders as well as new potential OI partners are identified and assessed concerning their relevance to the OI project. Suitable cooperation methods are derived for the selected OI partners, which can be differentiated in (a) an operative involvement of contributing to the goals of the OI project and (b) a strategic involvement to ensure its medium- and long-term success. In addition, the dissertation addresses further aspects of project management, such as incentive strategies, project controlling and risk management. The search of OI partners and selection of OI methods were implemented as software demonstrators to increase their usability. The evaluation by three case studies in industry was executed successfully. All three participating SMEs confirmed the usability and benefits of the methodical guideline.

Contribution to academia

The dissertation supports a more detailed understanding of enablers, barriers and the needs of successfully planning OI projects in SMEs. To address these needs, a discipline-spanning methodical guideline was developed. This guideline allows insights as to how results and approaches from different research areas can be consolidated into a holistic methodology.

The dissertation combines in particular the results and advantages of descriptive innovation management research with prescriptive engineering research. Therefore, engineering research benefits by the systematic exploitation and operationalisation of research results from innovation management. Other researchers can use these insights as well as the new methodical guideline and its single elements to plan external cooperation or to develop their own methodologies. In return, innovation management research benefits by in-depths insights and a more detailed understanding of processes, structures and culture in SMEs. The direct application and evaluation of the guideline in industry allows the evaluation of existing research results as well as the identification of new hitherto unconsidered aspects. Therefore, the dissertation contributes to the rising research field of OI in SMEs.

In addition to a primary knowledge gain for academia, the evaluation of the methodical guideline in real OI projects in industry also contributes to improved systematic knowledge transfer from academia to industry. It identifies success factors and barriers of method application in industry and derives insights as to how academic results need to be operationalised so that they can successfully be used by companies.

Implications for industry

Along with an improved understanding of OI in general, SMEs benefit from a methodology, which enables them to autonomously plan their OI projects as well as to profoundly evaluate external service offers. The modular structure allows for flexible use and adaptation to the specific context of the company and OI project. Unexperienced users are provided with a standard procedure, which helps to navigate through the planning process of an OI project. Experienced users can vary the sequence of planning steps, skip specific ones, add new ones or scale their intensity such as the search for new potential OI partners. In addition, single methods and tools can be utilised for tasks apart from OI. The purposeful discursive elements in each phase of the guideline allow the externalisation of individual and implicit knowledge and ensure a homogenous knowledge level within the particular OI project team.

Garching, December 2016

Prof. Dr.-Ing. Udo Lindemann

Chair of Product Development
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Beginners act within given boundary conditions – experts change them.

(unknown source)

SUMMARY

The methodology / methodical guideline ***Situational Open Innovation (SOI)*** supports Small and Medium-sized Enterprises (SMEs) in operatively planning Open Innovation projects. SMEs are the backbone of the German and European economy. A central factor of their success and innovativeness are collaborations with external partners. In this respect, Open Innovation (OI) represents a holistic framework for initiating and managing these collaborations. OI combines methods and tools of a distributed product development and collaborative innovation management. This allows a systematic knowledge exchange with external partners, such as suppliers, universities and user crowds, as well as the utilisation of their expertise and resulting advantages.

However, particularly SMEs are often unable to exploit these advantages and are confronted by several barriers and risks. Along with missed chances and wasted resources, this can lead to project failures and strategic damages of the company in the worst case. Empirical and literature-based studies revealed an unsystematic trial-and-error project planning as the central cause of insufficient OI projects. This increases the risk of neglecting relevant partners, involving unsuitable ones and choosing inappropriate collaboration methods.

This dissertation presents the methodology SOI, which supports particularly SMEs in operatively and systematically planning their OI projects. The central planning aspects and according requirements were identified by an empirical and literature-based study. SOI supports in analysing the specific OI situation, i.e. the company-internal and external context and the specific problem and goal of the project. Based on this, suitable partners are identified, who operatively contribute to a solution as well as who ensure the strategic long-term success of the OI project. Depending on the OI situation and the selected OI partners, appropriate OI collaboration methods are derived. Subsequently, SOI also addresses the planning of incentives, project controlling and risk management. To increase the usability of SOI, parts of it were implemented as a software demonstrator. To ensure the use and benefits in industrial practice, SOI was developed and successfully evaluated in cooperation with three German SMEs from the field of machine and plant engineering. Along with an operative step-wise guidance of unexperienced users, SOI can be adapted to the specific boundary conditions and needs of companies due to its modular setup. Thus, the sequence of planning steps can be varied, the scope of steps be scaled, and specific planning activities be skipped or replaced. The transparent planning process allows a profound decision support and leaves full control to the companies. Therefore, companies can autonomously plan their OI projects as well as profoundly evaluate offers of external service providers. This reduces the risk of planning mistakes and insufficient project outcomes.

The dissertation contributes to academia by systematically analysing the reasons which hinder SMEs in applying OI, and by deriving according research gaps. To bridge these, SOI adapts and combines elements of different research fields (such as OI, product development, system engineering and stakeholder analysis) with new developed methods and tools to an integrated

planning methodology. Other researchers can utilise it when developing their specific planning methodologies or when planning OI projects. The evaluation in companies also identified general success factors and barriers of method application in industry.

ZUSAMMENFASSUNG

Die Methodik der ***Situational Open Innovation (SOI)*** unterstützt mittelständische Unternehmen bei der operativen Planung von Open Innovation-Projekten. Mittelständische Unternehmen bilden das Rückgrat der deutschen und europäischen Wirtschaft. Ein wesentlicher Erfolgsfaktor für ihren Erfolg und ihre Innovationskraft ist die Kollaboration mit externen Partnern. Open Innovation (OI) stellt hierbei einen ganzheitlichen Ordnungsrahmen dar, um diese zu initiieren und zu steuern. OI vereint hierzu verschiedene Methoden und Werkzeuge einer verteilten Produktentwicklung und eines kollaborativen Innovations-managements. Dies ermöglich den systematischen Wissensaustausch mit externen Partnern, wie bspw. Zulieferern, Hochschulen und Nutzer-Crowds sowie die Nutzung ihrer Expertise und verschiedener resultierender Vorteile.

Vor allem mittelständische Unternehmen sind jedoch oftmals nicht in der Lage, diese Vorteile zu nutzen und sehen sich vielmehr mit verschiedenen Barrieren und Risiken konfrontiert. Neben verpassten Chancen und verschwendeten Ressourcen kann dies im schlimmsten Fall zu Projektfehlschlägen und strategischen Schäden für das Unternehmen führen. Wie empirische und literaturbasierte Studien ergaben, ist eine zentrale Ursache hierfür eine oftmals unsystematische Projektplanung mittels Trial-and-Error-Vorgehen. Dies erhöht das Risiko, wichtige Partner zu übersehen, ungeeignete Partner einzubinden und ungeeignete Kollaborationsformen zu wählen.

Mit SOI präsentiert diese Dissertation eine Methodik, die speziell mittelständische Unternehmen operativ bei der systematischen Planung von OI-Projekten unterstützt. Die betreffenden zentralen Planungsaspekte und zugehörige Anforderungen wurden basierend auf der zuvor genannten Studie systematisch identifiziert. SOI unterstützt bei der Analyse der jeweiligen OI-Situation, das heißt wichtiger interner und externer Randbedingungen und Einschränkungen sowie der konkreten Problem- und Zielstellung des OI-Projekts. Basierend hierauf werden geeignete Partner identifiziert, welche einerseits operativ zur Lösungssuche beitragen als auch andererseits den langfristigen strategischen Erfolg des OI-Projekts sichern. In Abhängigkeit der OI-Situation und der gewählten OI-Partner wird die Auswahl geeigneter OI-Kollaborationsmaßnahmen unterstützt. Anschließend adressiert SOI ebenfalls die Planung geeigneter Incentivierungsmaßnahmen, des Projektcontrollings und des Risikomanagements. Um die Anwendbarkeit der Methodik zu erleichtern wurden die Teilmethodiken der OI-Partnersuche und der OI-Maßnahmenauswahl im Rahmen von Software-Demonstratoren umgesetzt. Zur Gewährleistung der Nutzung und des Mehrwerts in der industriellen Praxis wurde die Methodik in Kooperation mit drei deutschen mittelständischen Unternehmen des Maschinen- und Anlagenbaus entwickelt und erfolgreich evaluiert.

Neben einer operativen schrittweisen Anleitung unerfahrener Anwender bietet SOI durch ihren modularen Aufbau die Möglichkeit, sie an die jeweiligen Randbedingungen und Bedürfnisse der Unternehmen anzupassen. So können beispielsweise die Reihenfolge von Planungsschritten variiert, der Umfang von Schritten skaliert, einzelne Planungsaktivitäten ausgelassen oder durch alternative ersetzt werden. Der transparente Planungsprozess erlaubt eine fundierte Entscheidungsunterstützung, wobei die Kontrolle jederzeit beim Unternehmen verbleibt. Auf diese Weise profitieren mittelständische Unternehmen, indem sie eigenständig OI-Projekte planen und mögliche externe Dienstleistungsangebote fundierter bewerten können. Dies reduziert das Risiko von Planungsfehlern und unzureichenden Projektergebnissen.

Der Mehrwert für die Forschung besteht in einer systematischen Untersuchung von Gründen, welche mittelständische Unternehmen von der Anwendung von OI abhalten können, sowie resultierender Forschungslücken. Um diese zu überbrücken, adaptiert und kombiniert SOI Elemente verschiedener Forschungsfelder (wie OI, Produktentwicklung, Systems Engineering und Stakeholder Analyse) mit neu entwickelten Methoden und Werkzeugen zu einem ganzheitlichen Planungsansatz. Dieser kann ganz oder in Teilen von anderen Forschern für eigene Planungsmethodiken oder zur Planung von OI-Projekten verwendet werden. Die Evaluation in Partnerunternehmen erlaubt zudem die Identifizierung allgemeiner Erfolgsfaktoren und Barrieren für eine Methodikanwendung in Unternehmen.

THE FOLLOWING PUBLICATIONS ARE PART OF THE WORK PRESENTED IN THIS DISSERTATION:

Journal publications

Guertler, M. R. (2014): ‘How to assess actors for an Open Innovation-project?’, Journal of Modern Project Management (JMPM), vol. 2, no. 2, pp. 56–63.

Guertler, M. R., Michailidou, I. and Lindemann, U. (2016): ‘How to assess a company’s Open Innovation situation?’, Design Science, vol. 2, pp. 1–30.

Guertler, M. R. and Lindemann, U. (2016): ‘Identifying Open Innovation partners: A methodology for strategic partner selection’, International Journal of Innovation Management, vol. 20, no. 5, pp. 1–20.

Book chapters and research reports

Guertler, M.R. (2013), “Open Innovation Interview-Studie 2012”, CiDaD Working Paper Series, Vol. 9 No. 1, pp. 1–21.

Lindemann, U., Guertler, M., Holle, M., Michailidou, I. and Becerril, L. (2016), “Forschungsbericht: KMU-spezifische Anwendung von outside-in Open Innovation”, München: bayme vbm.

Guertler, M. R. and Lindemann, U. (2016): ‘Innovationsmanagement’, In: Lindemann, U. (ed) Handbuch Produktentwicklung, Munich, Germany: Carl Hanser, pp. 483–512.

Conference papers

Guertler, M. R., Kain, A. and Lindemann, U. (2013): ‘Bridging the gap: From Open Innovation to an open product-life-cycle by using Open-X methodologies’, In: Chakrabarti, A. and Prakash, R. V. (eds) ICoRD'13: Springer India, pp. 1331–1343.

Guertler, M. R. and Lindemann, U. (2013): ‘Situative Open Innovation - A model for selecting the right external actors and involving them in an efficient way’, Proceedings of the 19th International Conference on Engineering Design (ICED13). Seoul, Korea, 19.-22.08.2013.

Guertler, M. R., Lewandowski, P., Klaedtke, K. and Lindemann, U. (2013): ‘Can stakeholder-analysis support Open Innovation?’, The Proceedings of The 6th ISPIM Innovation Symposium – Innovation in the Asian Century. Melbourne, Australia, 8-11 December 2013: LUT Scientific and Expertise Publications ISSN 2243-3384.

Guertler, M. R., Holle, M., Muenzberg, C. and Lindemann, U. (2014): ‘Open Innovation ganzheitlich und systematisch betrachten’, WiGeP News (Wissenschaftliche Gesellschaft für Produktentwicklung WiGeP), 2014, pp. 18–19 [Online]. Available at: http://www.wigep.de/fileadmin/download/wigep/WiGeP_News_2014_1.pdf (Accessed 26 May 2016).

Guertler, M. R., Holle, M. and Lindemann, U. (2014): ‘Open Innovation: Industrial application and demands - A qualitative study’, The R&D Management Conference 2014. Stuttart: Fraunhofer Verlag, pp. 1024–1030.

Guertler, M. R., Holle, M., Guber, D. and Lindemann, U. (2014): ‘How to determine a company's Open Innovation situation?’, DS 77: Proceedings of the 13th International Design Conference DESIGN 2014. Dubrovnik, Croatia, 19.-22.05.2014.

Guertler, M. R., Lewandowski, P. and Lindemann, U. (2014): ‘Stakeholder-analysis featuring Open Innovation’, The XXV ISPIM Conference 2014. Dublin, Ireland, 08.-11.06.2014.

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Guertler, M. R., Wiedemann, F. and Lindemann, U. (2015): ‘The relevance of stakeholder analysis for Open Innovation’, The R&D Management Conference 2015. Pisa, Italy, 23.-26.06.2015.

Guertler, M. R., Saucken, C. von, Schneider, M. and Lindemann, U. (2015): ‘How to search for Open Innovation partners?’, Proceedings of the 20th International Conference on Engineering Design (ICED'15). Milan, Italy, 27.-30.07.2015, pp. 21–30.

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Guertler, M. R., Becerril, L. and Lindemann, U. (2016): ‘How to identify suitable collaboration strategies for Open Innovation?’, Proceedings of the 14th International Design Conference: DESIGN 2016. Cavtat, Dubrovnik, Croatia, 16.-19.05.2016, pp. 1015–1024.

Guertler, M. R., Stahl, S., Muenzberg, C. and Lindemann, U. (2016): ‘Analysing the influence of planning-parameters on Open Innovation performance’, Proceedings of The XXVII ISPIM Innovation Conference. Porto, Portugal, 19.-22.06.2016, p. 1–11 (accepted for publication).

Saucken, C. von, Guertler, M. R., Schneider, M. and Lindemann, U. (2015): ‘A Method Model for Distinguishing and Selecting Open Innovation Methods’, Proceedings of the 20th International Conference on Engineering Design (ICED'15). Milan, Italy, 27.-30.07.2015, pp. 203–212.

CONTENTS

1. Introduction: Motivation, scope and research design

Small and medium-sized enterprises (Mittelstand enterprises) are the pillar of the German and the European economy due to employing the majority of workers and paying two-thirds of all taxes. To stay competitive on a global market with growing social and technological challenges, SMEs need to further increase their collaboration with external partners. In this respect, a powerful and promising innovation concept is Open Innovation (OI). The use of external expertise improves the effectiveness and efficiency of the companies' innovativeness. However, OI is mainly applied by large companies from the consumer industry and only reluctantly by SMEs and for engineering purposes – despite its benefits. A major reason is the lack of a sufficient methodical support for company- and situation-specifically planning OI projects. This chapter scientifically analyses this industry demand. It also presents the scope and the research design for developing a methodical solution approach, i.e. a methodology for operatively planning OI projects.

1.1 Motivation: Initial situation and problem description

Small and medium-sized enterprises (SMEs)[1] are of **great importance for the business location of Europe and Germany** (HOSSAIN 2013, p. 34). In particular, German SMEs comprise 3.7 million companies and represent 99.6% of all German companies (IFM BONN 2012), which correlates with the analysis results of AHSEN et al. (2010, p. 5). SMEs produce 57% of the entire German economic performance, and pay two-thirds of all taxes and social insurance contributions (PFOHL 2013, p. 29). They also employ up to 80% of all people working within the German industry (PFOHL 2013, p. 29). Therefore, WELTER et al. (2015, p. 1) and SOMMER (2016, p. 1) call them the "***backbone of the German economy***" and "*job engine*", while BERGHOFF (2006, p. 270) calls them the "*pillar of Germany's economy*". Particularly in times of the financial crisis, SMEs were of high importance for the German economy due to their stabilising function (SCHLÖMER-LAUFEN et al. 2014, p. viii). In contrast, large-scale enterprises are primarily net consumers due to subventions, paying taxes abroad and comprising less than 20% of all German employees (PFOHL 2013, p. 28).

However, SMEs **face several strengthening challenges**, like shortages of skilled workers due to the demographic change and increasing urbanisation (WELTER et al. 2014a, p. 23). A rising mobility and distribution of high qualified workers as well as fast growing and distributed knowledge in general are other challenges (BRAUN 2012, p. 7; GASSMANN 2006, p. 223; VAN DE VRANDE et al. 2009, p. 426). In addition, the usual suspect of globalisation causes a shift from local to global value chains (WELTER et al. 2014a, p. 22), and an increasing global competition (ENKEL 2009, p. 178; GASSMANN 2006, p. 223; ILI et al. 2010, p. 249; SCHUH 2013, p. 29). This makes it difficult to ensure the survival of the company and its competitive and

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[1] Chapter 2.4.2 discusses the commonalities and differences of the definitions of *SMEs* and *Mittelstand enterprises (Middle Sized Enterprises)*. Within this dissertation, these terms are considered synonyms and summarised as ***SMEs***.

innovative capabilities (RAHMAN AND RAMOS 2010, p. 484). From a product perspective, along with shortening product life and innovation cycles (ENKEL 2009, p. 178; VAN DE VRANDE et al. 2009, p. 426), dynamically changing and more diversified customer needs and the demand for an increased customer orientation are major challenges (COOPER AND EDGETT 2005, p. 32f; RAMASESH AND BROWNING 2014, p. 190f; SCHUH 2013, p. 92). Continuously growing costs of research and development activities (R&D) and simultaneously decreasing R&D budgets (ENKEL 2009, p. 178; RAHMAN AND RAMOS 2010, p. 484) are a particular problem for SMEs due to their generally limited resources (MEYER 2005, p. 292).

As a result, SMEs are forced to **labour division and cooperation**, whereby innovation networks are of a particularly high relevance (GASSMANN 2006, p. 223; VAN DE VRANDE et al. 2009, p. 426; WELTER et al. 2014a, p. 22) as well as identifying and sourcing external "*innovative knowledge*" (BOGERS AND WEST 2012, p. 68). Empirical studies prove that cooperating SMEs are more successful due to an increased innovation performance, i.e. a higher effectiveness of products and a higher efficiency of company processes (GERHARDS 2013, p. 20). Nevertheless, to enable this, first of all companies need a sufficient innovation management, which is a general challenge for SMEs (cf. MEYER 2013, p. 220).

A quite novel concept of cooperative innovation management is ***Open Innovation (OI)*** (CHESBROUGH 2003a; 2003b; CHESBROUGH AND BOGERS 2014). In addition to traditional external partners, such as single customers and suppliers, it focusses on collaborations with non-traditional types of partners and with large, unspecific crowds. In particular, new internet and social media technologies allow to use the increasing quantity of qualitatively improved external knowledge (CHESBROUGH 2003a, p. xx)[2]. These collaborations beyond the *usual suspects*, allow a variety of advantages for companies, such as a shortened time-to-market, a reduced flop rate, an information advantage, and the exploitation of new markets and sources of income (BRAUN 2012, p. 7, 9f; ECHTERHOFF 2014, p. 6; GASSMANN AND ENKEL 2004, p. 1; HOSSAIN 2013, p. 32; LOPEZ-VEGA et al. 2016, p. 126). A popular example from practice is the development of the **Nivea *Black & White* deodorant** (BILGRAM et al. 2013). The involvement of external OI partners prevented the company from developing an unwanted 96-hours deodorant, but allowed the identification of a strong need to reduce deodorant stains on clothing. After openly developing initial solution ideas and concepts with external OI partners, the actual development phase took place within the company. In the end, this new deodorant represents the hitherto most successful product launch in the history of the company (BILGRAM et al. 2013, p. 63). Due to these advantages, the application of OI in industry has been continuously increasing (BRAUN 2012, p. 3; CHESBROUGH AND BRUNSWICKER 2013, p. 2; GIANNOPOULOU et al. 2011, p. 505; WEST et al. 2014, p. 806).

Despite its benefits, **OI is still not applied comprehensively** to date. OI is mainly utilised in large companies from the consumer goods industry (GASSMANN et al. 2010, p. 219; HOSSAIN 2013, p. 30; 2015, p. 1). OI is only reluctantly adopted by SMEs and engineering issues although OI is particularly beneficial for small companies (BARGE-GIL 2010, p. 582f; HOSSAIN 2013, p. 34; 2015, p. 1; RAHMAN AND RAMOS 2011, p. 42; SPITHOVEN et al. 2013, p. 556; VAN DE VRANDE et al. 2009, p. 436). Academia has also tended to focus on large companies, which

[2] In this case, Chesbrough uses "xx" to indicate the Roman number of 20.

has been only slowly changing over the last years (ALBERTI AND PIZZURNO 2013, p. 156; ASCHEHOUG AND RINGEN 2013, p. 1; CARVALHO AND MOREIRA 2015, p. 17; RAHMAN AND RAMOS 2013, p. 431; SPITHOVEN et al. 2013, p. 555; TEIRLINCK AND SPITHOVEN 2013, p. 145). Hence, the demand, stated by GASSMANN et al. (2010, p. 215) and HOSSAIN (2013, p. 35), is still valid that a **stronger academic focus on OI in SMEs** is necessary.

Along with this, the **underlying reasons of this reluctant application of OI** in SMEs have not been analysed systematically. A potential reason might be that in the beginning, researchers focussed particularly on benefits of OI and successful OI projects while challenges and failures of OI were neglected (DAHLANDER AND GANN 2010, p. 700; GASSMANN AND SUTTER 2008, p. 4; HOSSAIN 2013, p. 35). Although authors, such as ENKEL (2009), KVISELIUS (2009) and MAURER AND VALKENBURG (2011), address risks and barriers of OI, their scientific analysis of sources and treatments is limited. OI still remains a challenge for companies, particularly for SMEs (WEST et al. 2014, p. 809) (GIANNOPOULOU et al. 2011, p. 506; GUERTLER et al. 2014b, p. 1029). Thus, it is necessary to analyse barriers and risks of OI in SMEs more systematically, to support SMEs to overcome them (HOSSAIN 2013, p. 35). In the beginning, unexperienced companies usually apply OI within OI projects (BOSCHERINI et al. 2010). Their defined scope and their decoupling from processes and structures of the company support test applications and reduce the risk of long-ranging negative effects in the case of a project failure (CHIARONI et al. 2010, p. 241).

In this respect, an essential aspect is the development of methodical support for companies since **OI is usually applied in a trial-and-error approach** with all its resulting problems (GASSMANN et al. 2010, p. 216; GUERTLER et al. 2014b, p. 1029; HUIZINGH 2011, p. 6), for instance, attracting unexpected OI partners due to insufficient participation settings or neglecting relevant OI partners (GUERTLER et al. 2014b, p. 1028; ILI AND ALBERS 2010, p. 56). In general, a methodical frame is missing, which also supports in handling the high context dependency of OI (BRAUN 2012, p. 3; GIANIODIS et al. 2010, p. 531, 559; TROTT AND HARTMANN 2009, p. 715).

Therefore, SMEs wish for **methodical support** particularly for planning OI projects. They face great challenges when applying OI for the first time. OI is more complex than closed innovation processes due to more and new activities, more actors, a higher effort of communication and coordination, and new barriers and risks (ENKEL et al. 2009b, p. 312; GIANNOPOULOU et al. 2011, p. 505; VAN DE VRANDE et al. 2009, p. 425). Many companies lack the required methods, processes, systems and culture to implement OI (ILI AND ALBERS 2010, p. 56). In particular SMEs, with their limited resources and capacities, need methodologies, methods and tools to systematically apply OI and overcome implementation barriers (HOSSAIN 2015, p. 2; SALVADOR et al. 2013, p. 356). HUIZINGH (2011, p. 6) calls it the need for a "***decent cookbook***" of a systematic cooperation management (also: GERHARDS 2013, p. 31f; SALVADOR et al. 2013, p. 356). Since OI projects depend on their context (DITTRICH AND DUYSTERS 2007, p. 512; HUIZINGH 2011, p. 5; SOLESVIK AND GULBRANDSEN 2013, p. 15), the methodology has to particularly consider specific boundary conditions and constraints, to adapt OI accordingly (LOREN 2011, p. 10), and select suitable OI partners and OI methods (HOSSAIN 2015, p. 5).

1.2 Scope and objectives of dissertation

This chapter summarises the research scope, the goal and objectives of this dissertation.

1.2.1 Scope and focus of research

This dissertation addresses the research fields of **product development** and **innovation management**, i.e. it does not consider specific products and innovations but the underlying processes, activities, methods and tools. The focus is on the development of new or improved mechanical and mechatronic products as well as product service systems (PSS) for B2B and B2C customers. For instance, topics related to exclusively software, society, environment, agriculture and education are not addressed. A marketing perspective of OI is also not addressed, i.e. using OI as public relationship (PR) instrument to attract new recruits or *rescue* a failed project. From an **engineering perspective**, OI directly links to established approaches from product development, such as systems engineering (HASKINS 2006; SCHULZE 2016), distributed product development (GAUL 2001; GRIEB 2008; KERN 2016), and supply-chain management (LAMBERT AND COOPER 2000). Nevertheless, OI enhances them by the use of new internet technologies, cooperation methods and involvement of new types of external partners.

The dissertation aims at supporting in particular SMEs without any experience with OI. It focusses on **outside-in OI**, as it is easier for companies to start with gaining external knowledge than revealing it to externals in terms of inside-out OI (HUIZINGH 2011, p. 4). In this respect, **projects** are of high importance as starting point of OI. They have a defined scope and are decoupled from the company's processes. Therefore, the latter are not affected in the case of a project failure (BOSCHERINI et al. 2010; CHESBROUGH AND BRUNSWICKER 2013, p. 20; CHIARONI et al. 2010, p. 241; LOREN 2011, p. 14). In addition from a research perspective, OI itself has mainly be considered on a company level by academia while neglecting a project perspective (KIM et al. 2015, p. 411). However, the majority of OI activities is executed as projects within superordinate R&D projects (CHESBROUGH 2003b; KIM et al. 2015, p. 411; LOPEZ-VEGA et al. 2016, p. 135). Thus, an intensified research focus on OI projects is required.

This dissertation focusses on the **planning phase** due to its high relevance to the success of an OI project (cf. Figure 1-1). The planning phase is essential as it defines the procedure, solution space and constraints of the following project. Mistakes in this early phase cannot or only hardly be compensated in later phases (cf. *rule-of-ten*). As illustrated in Figure 1-1, the strategic decision for or against an OI project is excluded as well as the actual execution of the OI project, and the operationalisation of the gained OI input within the internal innovation process.

Central elements of OI are the contact to external partners and the purposeful knowledge transfer between them and the focal company (cf. CHESBROUGH et al. 2006, p. 1). Both elements are dependent on the specific context of the company and OI project (HUIZINGH 2011, p. 5). Therefore, within the planning phase, this dissertation primarily focusses on supporting in analysing the OI project's goal and relevant boundary conditions (*"OI situation"*) as well as selecting suitable OI partners and OI methods. It aims at operative methodical support for SMEs, i.e. an adaptable step-by-step guideline.

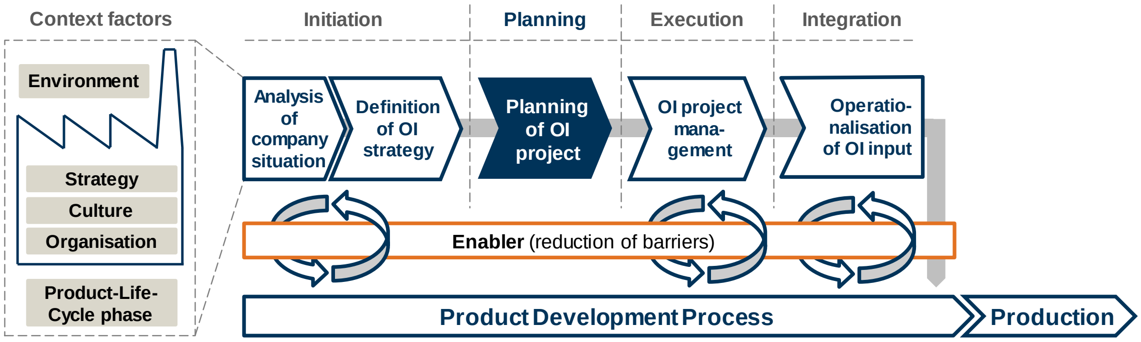

Figure 1-1: Map of Open Innovation and focus of this dissertation (based on: GUERTLER et al. 2014a)[3]

As illustrated in Figure 1-2, the underlying engineering perspective of this dissertation helps to bridge the **barrier of knowledge transfer** of traditional innovation management science. The latter observes and analyses processes, methods and tools in industry by descriptive studies, and publishes the results to a mainly academic audience. However, a transfer of operationalised insights back to industry is usually missing.

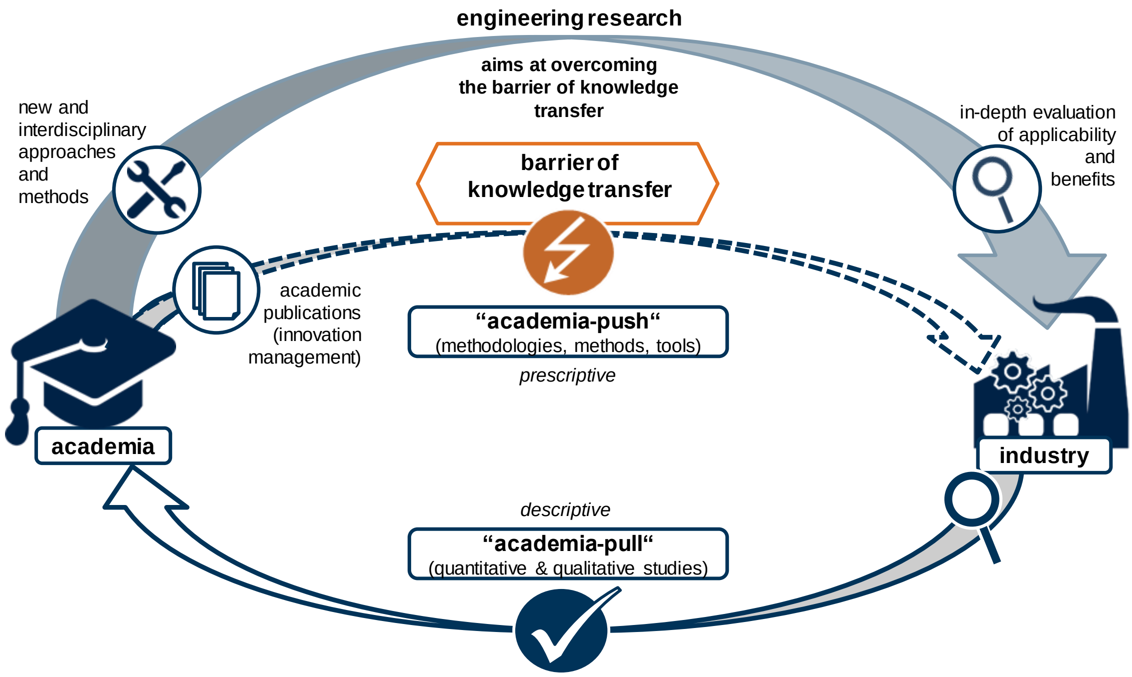

Figure 1-2: Academic knowledge circle and focus of engineering research

This can mean that relevant challenges, underlying reasons and potential solutions are identified by academia, but they are not sufficiently communicated back to industry. Companies often perceive academic publications as too abstract or too focussed on specific issues for a practical application. This represents a great shortcoming as companies are often not aware of these challenges and solutions, and would benefit from their knowledge. From an innovation

[3] The model was developed in cooperation with Andreas Kain, Maik Holle and Alexander Lang. The phases are in correspondence to PMI (2013, p. 49).

management perspective, industry is merely considered a source of knowledge rather than a receiver. In contrast, **engineering research** adapts and enhances and processes academic knowledge for industry, and brings it back to companies to solve their identified needs. By in-depth case study evaluations of this prescriptive research, this methodical support is analysed, in order to validate its effects and benefits. These insights further extend the body of academic knowledge.

1.2.2 Objectives and research questions

This dissertation focusses on a SME-specific integrated methodical support for OI teams[4] in systematically planning outside-in OI projects. This shall support the following objectives.

Objectives

From an **industry perspective**, the wanted methodology[5] shall provide operative and prescriptive support in systematically planning OI projects, in order to avoid negative effects of the common trial-and-error approach. By using the methodology, SMEs shall be enabled to autonomously plan their OI projects as well as to evaluate external service offers more profoundly. Therefore, the planning methodology has to cover all relevant planning steps with a particular focus on analysing the relevant OI situation and selection of OI partners and OI methods. In this respect, the methodology shall help to identify relevant OI partners and reduce the risk of neglecting relevant ones, as well as to derive suitable forms of cooperation. SMEs shall be provided with a systematic decision support but keep control of the regarding process. In addition, the methodology shall be adaptable and applicable in different company and project contexts. The in-depth evaluation in OI projects in industry shall ensure the applicability in SMEs.

From an **academic perspective**, reasons and barriers shall be identified, which hinder SMEs to apply OI. These are the basis for deriving and prioritising open research gaps and promising research fields, which can also be used by other researchers. To solve the selected research gaps, approaches from different research fields are applied, such as product development, systems engineering, OI, stakeholder analysis and Lead User approach. This ensures the embedding of OI into a larger research context and allows insights, how different research fields can be combined to a holistic approach. Along with ensuring the methodology's applicability in industry, the evaluation provides insights in general success factors and barriers of method application in SMEs. These need to be operationalised so other researchers can use them for their own research.

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[4] The OI team comprises all employees that are responsible for operationally planning, executing and post-processing an OI project.

[5] From an engineering perspective, a methodology represents a kind of prescriptive methodical guideline which helps to navigate through a particular process like the planning process of a project (cf. chapter 2.1).

Research questions

Based on these objectives, the following research questions can be derived, as illustrated in Figure 1-3:

What are context factors, which influence or constrain an OI project? Depending on this, the subsequent question is: ***Who are relevant operative and strategic, external and internal OI partners?*** Directly linked is the question: ***Which OI collaboration methods are appropriate to involve them?*** Although these three questions are in the primary focus of the dissertation, it is also necessary to address aspects concerning the long-term success of OI in a company, the questions are: ***How can OI and product development be combined? Which barriers can occur?*** This comprises aspects like risk management and project controlling, which are also considered but need to be addressed in more detail in following research activities.

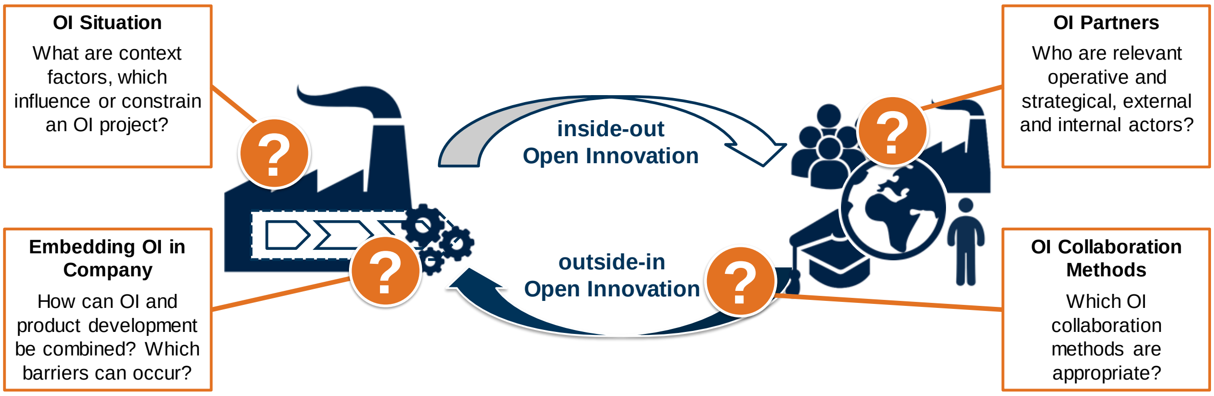

Figure 1-3: Central research questions of this dissertation

1.3 Research design and environment

The following section explains the research design of this dissertation to address the previous research questions and the corresponding research context.

1.3.1 Design Research Methodology

The research design of this dissertation is based on the ***Design Research Methodology (DRM)*** of BLESSING AND CHAKRABARTI (2009). By the use of case-studies, this qualitative research allows in-depth insights in processes and needs of SMEs, which is the basis of the development of an appropriate methodical support. In addition, a detailed evaluation ensures its applicability and reveals further points for improvement of the developed methodology (cf. HUIZINGH 2011, p. 6; LOPEZ-VEGA et al. 2016, p. 135; YIN 2014). In this respect, it combines descriptive elements for identifying needs in industry and prescriptive elements for providing companies with support in overcoming their needs. This case study-based evaluation also comprises elements of ***action research*** to ensure the applicability of the OI planning methodology in industry (BLESSING AND CHAKRABARTI 2009, p. 273; LINGARD et al. 2008). Figure 1-4 illustrates the structure of the DRM and the correlating chapters of the dissertation.

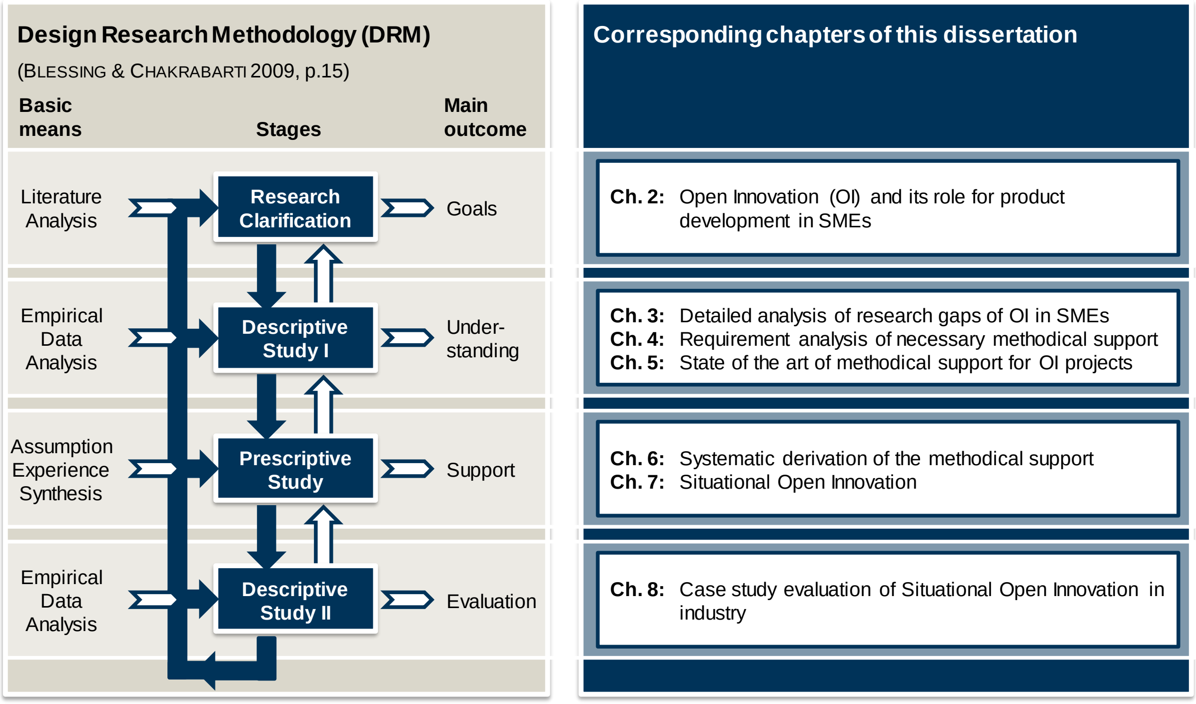

Figure 1-4: Design Research Methodology and corresponding chapters of the dissertation

The **research clarification (RC)** provides an overview of the general research context of OI and its links to product development as well as the identification of the large research demand, i.e. enabling OI in SMEs.

The **descriptive study I (DS I)** identifies specific research gaps within the large research demand. A literature analysis derives needs of OI in SMEs. These are evaluated by an empirical study and consolidated to nine research gaps. Their prioritisation is the basis to select three central (*analysis of OI situation, selection of OI partners, selection of OI methods*) and three supplementary research gaps (*prevention of OI risks, incentive strategies, OI performance controlling*). Subsequently, requirements of a methodical support for each gap are derived based on an analysis of relevant characteristics of SMEs, the study results in literature and an empirical requirement analysis with the industry partners of the research project *KME – Open Innovation*. Based on them, existing approaches of each research gap and field are identified and assessed concerning the requirements.

The **prescriptive study (PS)** develops a methodical framework of a holistic OI planning methodology that comprises different sub-methodologies, methods and tools to solve the selected research gaps. It uses the defined SME-specific requirements to assess existing planning approaches and to derive suitable elements, which can be adapted and used within the OI planning methodology. In addition, open gaps are identified and addressed by new developed methods and tools.

Within the **descriptive study II (DS II)**, the developed OI planning methodology is evaluated in detail by three in-depth case studies in different companies and industry sectors. An **action research** approach (cf. LINGARD et al. 2008) allows the identification of benefits and shortcomings of the methodology, and the reflexion of underlying reasons. This supports a step-wise improvement of the methodology towards a generally applicability. Along with these three large case studies, specific elements of the OI planning methodology are pre-evaluated in smaller case studies.

1.3.2 Research context and experience of the author

The results presented in this dissertation are based on the following research activities of the author during his occupation as research assistant at the Chair of Product Development of the Technical University of Munich (TUM). The central research project was ***KME - Open Innovation*** (*KMU-spezifische Anwendung von outside-in Open Innovation*), funded by the Kompetenzzentrum Mittelstand GmbH (short: KME, a joint venture of TUM and the employers' associations of the metalworking and electrical industries in Bavaria: *bayme vbm*). In cooperation with three SMEs from the field of mechanical and plant engineering, the sub-methodologies for analysing an OI situation, and selecting suitable OI partners and OI methods were developed and evaluated. A detailed analysis of potential risks and barriers in open collaborations was conducted in the context of the joint research project ***RAKOON*** (the German acronym for: *Progress by active collaboration in open organisations - life-cycle-stage adequate competence management*). The three-years project comprises four academic partners from the field of engineering, sociology and pedagogics and three industry partners, and is funded by the German Federal Ministry of Education and Research. Basic insights of OI in industry was yielded in two smaller projects with industry partners: a **cooperation with SGL Carbon** allowed valuable insights in organising and operationalising a multitude of collected ideas within an ideation contests (in this case for the task of finding alternative fields of application for carbon-fibre reinforced concrete). Within the **cooperation with the Knorr Bremse AG**, a methodology for identifying and utilising potential synergies between two business units was developed, quasi as a form of internal OI that opens the innovation processes of different business units. General experience of developing methodical support for engineering companies was gained in the context of the three-years EU-funded research project ***AMISA*** (*Architecting Manufacturing Industries and Systems for Adaptability*) in cooperation with one other academic partner and six industrial partners from five different countries and cultures (Italy, Spain, Israel, Romania, and Germany).

The presented research was also supported by several **student theses** (as listed in appendix 13.1), which were intensively supervised by the author and which were partly in cooperation with industry partners. The majority of these theses led to co-authored publications that are cited accordingly within this dissertation. The remaining theses are also cited but indicated as unpublished theses by an initial "*PE*", for instance (*PE: Ginard 2015*).

Intermediate results of this dissertation were published in **journals** and at **international conferences**. The intensive discussion with researchers from product development, innovation management and other disciplines provided valuable feedback for further enhancing the developed OI planning methodology. Additional important feedback was gained during a two-month research visit to the Engineering Systems Division of the **Massachusetts Institute of Technology** (MIT) under the supervision of Dr Eric Rebentisch.

1.4 Structure of the dissertation

Figure 1-5 illustrates the structure of this dissertation. Based on the introduction in **chapter 1**, **chapter 2** gives an overview of product development and its role within the innovation process of a company. Subsequently, the concept of Open Innovation (OI) is introduced as well as its benefits and challenges for SMEs. **Chapter 3** analyses SME-specific needs concerning a successful application of OI in more detail and derives the central research gaps for the following thesis. **Chapter 4** analyses different literature-based and empirical requirements of a methodical support that enables OI projects in SMEs. They are utilised for evaluating existing approaches of planning OI projects in **chapter 5**. This is the basis of **chapter 6** for systematically deriving the methodology for systematically planning outside-in OI projects, presented in **chapter 7**. **Chapter 8** evaluates the developed methodology in the context of OI projects in industry. The derived benefits and limitations are discussed in **chapter 9**, which also summarises the results of the dissertation and provides an overview of future research activities.

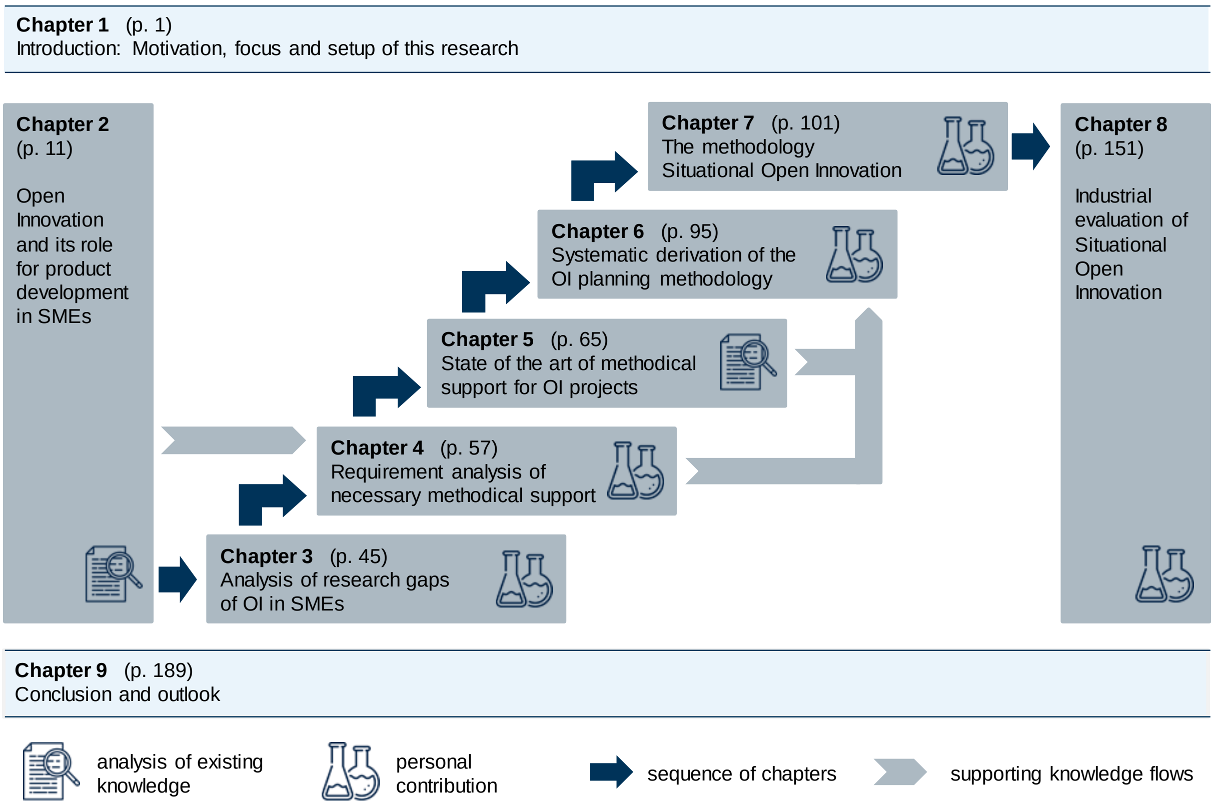

Figure 1-5: Structure of the dissertation

2. Open Innovation and its role for product development in SMEs

The following chapter provides an overview of the theoretical frame and background of this dissertation. It explains the interdependencies between innovation process and product development process as well as the specific role of product development projects. Subsequently the chapter describes how product development projects can be opened for external knowledge by using Open Innovation (OI), and the particular relevance of a project organisation for OI. In addition, typical OI partners and collaboration methods are presented as well as potential benefits and risks. The utilisation of OI in SMEs is analysed in detail, focussing on reasons for OI as well as success factors and barriers in SMEs. Both, risks and barriers also serve as indicators of potential industry needs and research gaps for the following chapter.

2.1 Key terms and concepts

The following terms and concepts are central for the following research and the understanding of the dissertation.

Methods support product development activities, for instance, within product engineering models. Methods represent a rule-based and systematic approach to reach a specific goal. They have a prescriptive and operative character. While product engineering models describe ***which*** activities should be performed, methods explain ***how*** to execute them (EHRLENSPIEL AND MEERKAMM 2013, p. 146f; LINDEMANN 2009, p. 57f; ULRICH AND EPPINGER 2008, p. 7).

In the context of this dissertation, **Open Innovation (OI) methods** are particular collaboration methods for interacting with OI partners. In literature, they are sometimes also addressed as *"instruments"* (cf. MÖSLEIN AND NEYER 2009, p. 96).

Method tools are technical implementations of methods (LINDEMANN 2009, p. 62). They support the operational application and the usability of methods and increase their effectiveness and efficiency (KIRSCHNER 2012, p. 33). They can range from simple paper-based tools like forms and checklists to complex software systems.

Methodologies are consistent bundles and combinations of single methods (KIRSCHNER 2012, p. 32; LINDEMANN 2009, p. 58). PAHL et al. (2007, p. 9) define a design methodology as "*concrete course of action for the design of technical systems (...). It includes plans of action that link working steps and design phases according to content and organisation*".

A **product** is defined as anything that can be offered to a person to fulfil a need or a wish (KOTLER et al. 2007, p. 12). This product can be a physical, often mechatronic **system**, a service or a combination, a so called ***product service system (PSS)*** (SCHENKL 2015, p. 45; TUKKER 2004, p. 248). Systems and actors can be characterised by **properties**. These consists of **criteria** (e.g. size) and particular **specifications** (e.g. 1800 mm) (cf. LINDEMANN 2009, p. 160).

In the context of this dissertation, a **problem** is defined as delta or difference between the current state and a target state, for instance, an engineering task (ALBERS et al. 2005, p. 2).

2.2 Product development as a basis of Open Innovation

To understand the mechanisms and industry needs concerning OI, it is necessary to have a deeper look onto the underlying elements. Therefore, this chapter analyses the characteristics of inventions and innovation, the processes of developing inventions and transforming them into innovations as well as existing methodologies that can serve as a basis for the development OI-specific support for SMEs.

2.2.1 Innovation Process

Central part of the innovation process is the development of **inventions**. Based on DEUTSCHES PATENTAMT (1995, par. 3.3.2.4.2), HAUSCHILDT AND SALOMO (2007, p. 15) define an invention as result of research and development (R&D) that represent a first-time realisation of a novel problem solution. Besides the novelty of the invention and the increase of customer benefits, a successful application is the prerequisite for an invention to become an **innovation**. Traditionally this means a successful commercialisation of the invention (BOGERS AND WEST 2012, p. 64; BRUHN 1999, p. 207; EHRLENSPIEL AND MEERKAMM 2013, p. 371; GASSMANN AND SUTTER 2008, p. 5; HERZOG AND LEKER 2011, p. 9; SCHUMPETER 1934, p. 88). However, commercialisation mainly applies for product or service innovations while process innovations are usually used company-internally. Additionally, concepts like *user innovation* are blurring the lines of commercialisation since there is no company with an intension of profit but the success is defined by the level of diffusion of an invention (BALDWIN AND HIPPEL 2011, p. 1399f). Therefore, BOGERS AND WEST (2012, p. 65) generally consider an innovation as "*conversion of that invention into business or other useful application*". In this context, MEYER (2013, p. 221) defines two central terms: (1) **adoption**, as acceptance of an innovation on the market, and (2) **diffusion**, as dissemination of an innovation on the market.

Based on the object of innovation, different **types of innovations** can be distinguished (INAUEN AND SCHENKER-WICKI 2012, p. 214; MÖSLEIN 2009, p. 8f) such as **product innovation** (new products and services that increase the economic effectiveness of the company from a company-external perspective (BOGERS AND WEST 2012, p. 63)), **process innovation** (increasing the efficiency of a company from a company-internal perspective by improving the processes of an existing product (like manufacturing) (BOGERS AND WEST 2012, p. 63)), **sources of supply innovation** (like utilising new suppliers or the substitution of materials by new ones), **exploitation of new markets / business model innovation** (new approaches of organising a company's business, include the exploitation of new markets (GASSMANN AND SUTTER 2008, p. 10)), **service innovation** (a relatively new type of innovation that combines product and process innovation (BOGERS AND WEST 2012, p. 63; HAUSCHILDT AND SALOMO 2007, p. 9), and **administrative innovations** (also a relatively new type of innovation, which is closely linked to process innovations (BOGERS AND WEST 2012, p. 63).

Another characteristic of innovations is their **level of novelty**. From a product development perspective, PAHL et al. (2007, p. 64) and ALBERS et al. (2015b, p. 16) differentiate **original design** (new solution principles or new combinations of known solution principles for solving new tasks and problems), **adaptive design** (existing solution principles are used under new application conditions) and **variant design** (reuse of existing solution principles and under similar application conditions but adapted to specific objectives of the development project). Since most product development projects are **product generation development** projects, ALBERS et al. (2015b, p. 18) present an adapted characterisation that differentiates principle variations and shape variations of new partial systems, along with carryover parts[6].

From an innovation perspective, it is more common to differentiate innovations into the following categories (BOGERS AND WEST 2012, p. 63; GASSMANN AND SUTTER 2008, p. 9f; INAUEN AND SCHENKER-WICKI 2012, p. 214; MEYER 2013, p. 221f; REICHWALD AND PILLER 2009, p. 121f): **incremental innovation** (small improvements based on existing solutions but low technological risks), and **radical** or **disruptive innovation** (breakthrough innovation with fundamental changes and high technological risks; comparable to *original designs*). In addition, HENDERSON AND CLARK (1990, p. 12) mention **modular innovation** (comparable to incremental innovation but with overturned *core concepts*) and **architectural innovation** (comparable to radical innovation but with only *reinforced core concept*).

The creation of innovations is based on the combination of knowledge from different sources and perspectives, i.e. it is a collaborative and interactive process of product developers and other actors within a social system (BERGMANN et al. 2009, p. 139f). This already indicates that innovations usually are not a random product but happen within a systematic innovation process and management. The main purposes of such an innovation process are (1) focussing the scope of innovation activities, (2) identifying promising ideas for the development of potential innovations, and (3) developing, assessing and selecting alternative solutions (MEYER 2005, p. 293). Based on this, the purposes of innovation management are the definition of innovation goals, the definition of an innovation strategy, the definition and assessment of innovation projects, the realisation and controlling of innovations as well as the creation of innovation systems and cultures (HAUSCHILDT AND SALOMO 2007, p. 85f; MEYER 2013, p. 225).

In general, linear and non-linear innovation processes can be distinguished (for a detailed consideration see KAIN (2014, p. 17)). In reality, an innovation process is characterised by iterations, jumps and recursions (GASSMANN AND SUTTER 2011, p. 49; GAUSEMEIER 2001, p. 39f). Nevertheless, a linear consideration allows for a better structuring and management of the process (KAIN 2014, p. 18). In line with the previously mentioned goals, HERZOG AND LEKER (2011, p. 11) define three main phases that are in accordance to the results of a detailed analysis of different innovation processes by KAIN (2014, p. 20f), as illustrated in Figure 2-1: (1) **front end of innovation** with focus on identifying promising ideas, (2) **idea realisation and product development** for advancing and developing ideas to inventions, and (3) **commercialisation (and after sales)** addressing the transition of inventions to innovations and the utilisation of the product on the market. Depending on the focus of application and the analysis perspective, these phases can be subdivided into different sub-phases. For more details, refer to KAIN (2014, p. 20f).

[6] For more details see ALBERS et al. (2015b, p. 18f; 2015c, p. 4f; 2016c, p. 791f).

2.2.2 Product Development

The central element of an innovation process is the **product development process**, which is located after the product strategy planning phase and before the production phase (KAIN 2014, p. 24f). In line with BAUMBERGER (2007, p. 128) and BROCKHOFF (1997, p. 354), ULRICH AND EPPINGER (2008, p. 12) define: "*A **product development process** is the sequence of steps or activities which an enterprise employs to conceive, design, and commercialize a product.*". By considering the commercialisation of a product, the definition is overlapping with the innovation process.

The product development process is part of the **product engineering process** that also comprises the development of production machines and planning of the production process (ALBERS AND BRAUN 2011, p. 7). It itself is part of the superordinate innovation process and product life cycle (BAUMBERGER 2007, p. 128).

Figure 2-1 illustrates the relationship between innovation, product engineering and product development process. The product development process itself can be further subdivided into three main phases (BAUMBERGER 2007, p. 129; LINDEMANN 2009, p. 46; ULRICH AND EPPINGER 2008, p. 13f): (1) **clarification of goal and engineering problem** by defining the development task and corresponding solution space, (2) **development of alternative solutions** by structuring the development task and developing alternative solutions, and (3) **decisions for solutions** by testing, assessing and selecting solutions as well as evaluating the decision.

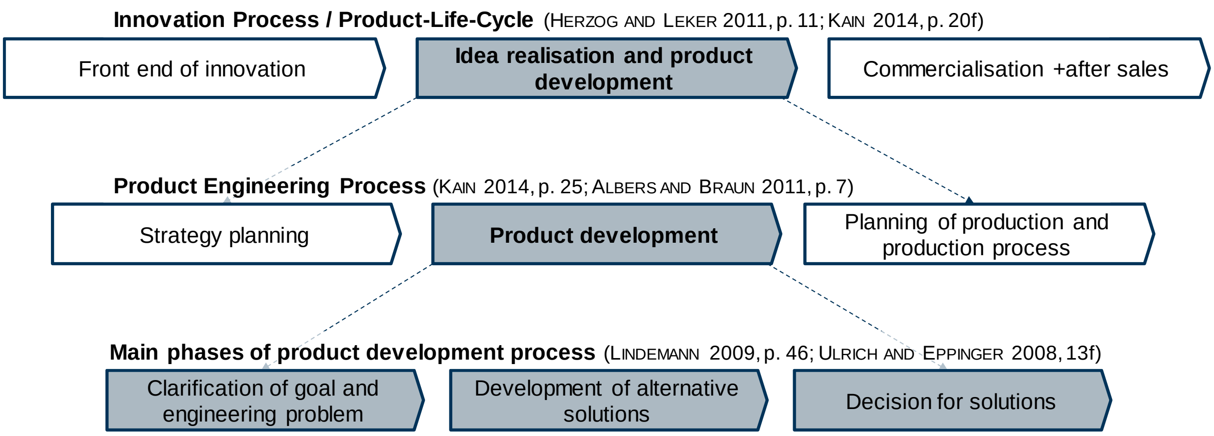

Figure 2-1: Differentiation of innovation, product engineering and product development process

Identically to innovation processes, product development is a **cooperative and interdisciplinary** process, which involves product developers and actors from different departments (PAHL et al. 2007, p. 138). Although ULRICH AND EPPINGER (2008, p. 3) still see the design, manufacturing and marketing departments as central functions for product development, they also stress its interdisciplinary character. All departments that are involved in the development and production of a product should be involved early, for instance, in terms of simultaneous engineering or by supplier and customer collaborations (EHRLENSPIEL AND MEERKAMM 2013, p. 227).

A holistic product development approach focussing on the interdisciplinary collaboration of product developers and considering the product as a socio-technical system, is **systems**

engineering (DAENZER AND HUBER 2002; HASKINS 2006, p. 2.1; NASA 2007; SCHULZE 2016). Along with the central role of humans (such as developers, users and testers) within product development, the consideration of company-internal and -external stakeholders[7] from all phases of the product life cycle is a main characteristic of systems engineering. Both aspects are also important for the Open Innovation planning methodology in the following chapters.

2.2.3 Organising product development and the specific relevance of projects

To successfully develop and manufacture products, it is crucial to **define corresponding tasks, processes and responsibilities** (LINDEMANN 2009, p. 12f). Overall purpose of a systematic development approach are a holistic mind-set, an alignment of all activities towards a defined goal and the development of appropriate procedures and ways of behaviour (LINDEMANN 2009, p. 14). This includes quality assurance by defining specific process check-gates and assessment criteria. In addition, the process is coordinated by defining roles and responsibilities of planning activities, along with managing the development progress in terms of project controlling and improvement of the product development process by documenting and reflecting each product development project (ULRICH AND EPPINGER 2008, p. 12f). Traditional structures are the **organisational structure** based on the department structure of a company with defined responsibilities, and the **operational structure** based on recurring activities that define necessary processes within the company. The organisational structure can be further differentiated into divisional structures, functional structures and matrix structures as a combination of the previous forms (LINDEMANN 2009, p. 12).

However, often product development and innovation management in general are organised on a project basis (HASKINS 2006, p. 5.1; HAUSCHILDT AND SALOMO 2007, p. 88; LINDEMANN 2009, p. 16). A **project** is defined as a temporary undertaking with a specific start and end, a specific goal, a defined project team, allocated resources and clear distinction from other endeavours. It is unique in terms of unity of conditions and constraints (BOSCHERINI et al. 2010, p. 1071; DIN 69901; PMI 2013, p. 3; RAMASESH AND BROWNING 2014, p. 190). As explained in more detail in chapter 2.3.1, projects and a project perspective are particularly relevant for Open Innovation (OI): on the one hand, OI is often applied in the context of a superordinate innovation project. On the other hand, OI itself is usually executed on a project base.

Project management supports project managers in defining work packages including tasks, their sequence, intended output, necessary inputs, supporting resources, responsibilities and roles, and performance measures (HASKINS 2006, p. 5.2f; LINDEMANN 2009, p. 17). Project management itself is enabled by according methods and tools.

2.2.4 Methodical support for product development

To allow a successful and purposeful planning and execution of product development projects, methodical support is required. Similar to cooking recipes, they provide guidance to

[7] For a detailed discussion of stakeholders refer to chapter 5.3.3.

unexperienced users and inspiration to experienced ones. GRANER (2013) empirically proves the benefits of method application by analysing more than 400 product development projects in industry. While **product engineering models** describe **what** activities product developers should do, **methods** explain **how** they should execute these activities (LINDEMANN 2009, p. 58). This chapter gives an overview of established product engineering models. For more details, see the cited references of each model as well as EHRLENSPIEL AND MEERKAMM (2013), GAUSEMEIER (2001), LINDEMANN (2009) and ULRICH AND EPPINGER (2008).

Product engineering models for structuring and planning innovation processes

Product engineering models provide support in planning and managing sequences of product development activities on a process level. Users can navigate through the process by locating themselves within the process and identifying subsequent steps as well as reflecting and controlling their approach (ALBERS AND BRAUN 2011, p. 10; LINDEMANN 2009, p. 36). Despite a varying number of steps, LINDEMANN (2009, p. 46) identifies three main phases that are part of each product engineering model: (1) **clarification of goal and engineering problem**, (2) **development of alternative solutions**, and (3) **decisions for solution alternatives**. The models differ in their specific objectives, boundary conditions and object of innovation. In general, engineering models can be differentiated in terms of their **level of abstraction** (BRAUN 2005, p. 29) – ranging from a micro level with a descriptive and domain-spanning character (e.g. TOTE model (MILLER et al. 1960, p. 26)), to a macro level with a prescriptive and domain-specific character (e.g. V-Model or VDI 2221). In addition, they can also be distinguished regarding their **level of flexibility** – from inflexible procedures (e.g. Stage-Gate Model (COOPER 2001)) to agile models (e.g. scrum (SCHWABER 2007)). The following section gives an overview of exemplary product engineering models that serve as basis for the OI planning.

The **V-Model** (also **VDI 2206** in German) focusses on the methodical development of mechatronic products (VDI 2206). They face the challenge to coordinate and combine the three disciplines of mechanics, electronics and software. As shown in Figure 2-2 (left), the development process starts in the in the upper left arm of the V by defining requirements of the mechatronic product. Following the V's arm down, these requirements get more detailed and differentiated into discipline-specific requirements. At the bottom of the V, discipline-specific partial solutions are developed. These partial solutions are integrated to a consistent product following the right arm upwards. In this respect, the requirements from the left arm serve as assessment criteria of the property reconfirmation. Over the years, the V-Model was adapted and enhanced by different functions, like agile elements within the V-Model XT.

The **VDI 2221** ("*Systematic approach to the development and design of technical systems and products*") is a widely established product development guideline by *The Association of German Engineers (VDI)*. It describes the general methodical procedure for developing and designing technical systems. The procedure is divided into seven steps, as shown in Figure 2-2 (right). Along with the process steps, specific documents as intermediate results are defined. By an increasing level of concretisation, these intermediate results also serve as inherent progress control. VDI 2221 is suitable for different products with a light focus on mechanical products and complex engineering tasks. At the moment, VDI 2221 gets revised and updated.

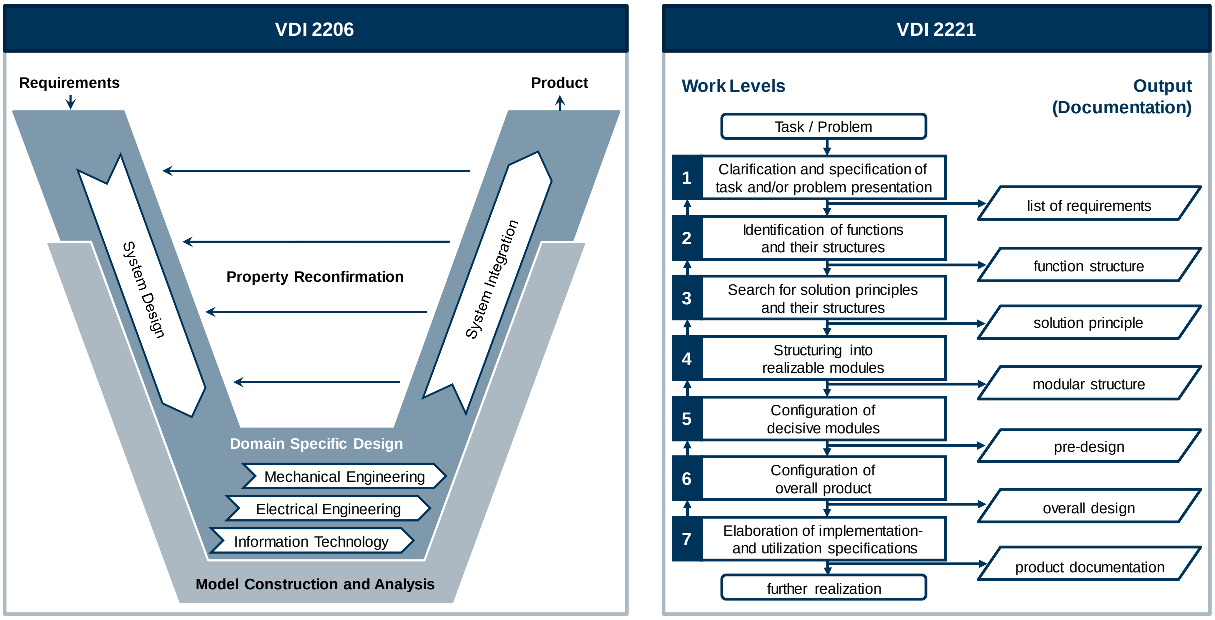

Figure 2-2: Engineering models of VDI 2206 (left) and VDI 2221 (right)

The **Munich Procedure Model** is based on the analysis of different other product engineering models as well as insights from industry and research projects in cooperation with sociologists and psychologists. It allows an industry sector- and discipline-spanning application for solving engineering and non-technical problems. It comprises seven elements that cover the entire development process from the planning of the project's goal, via the generation of solution ideas to the ensuring of the goal achievement, as illustrated in Figure 2-3. These elements are scalable and allow a flexible as well as iterative and recursive execution depending on the particular development project. Nevertheless, to support unexperienced users, a standard procedure is highlighted to guide them through the model. The Munich Procedure Model focusses on an intensive examination of the goal of a project and subordinate objectives as well as the ensuring of the goal achievement, including the consideration of product development crises.

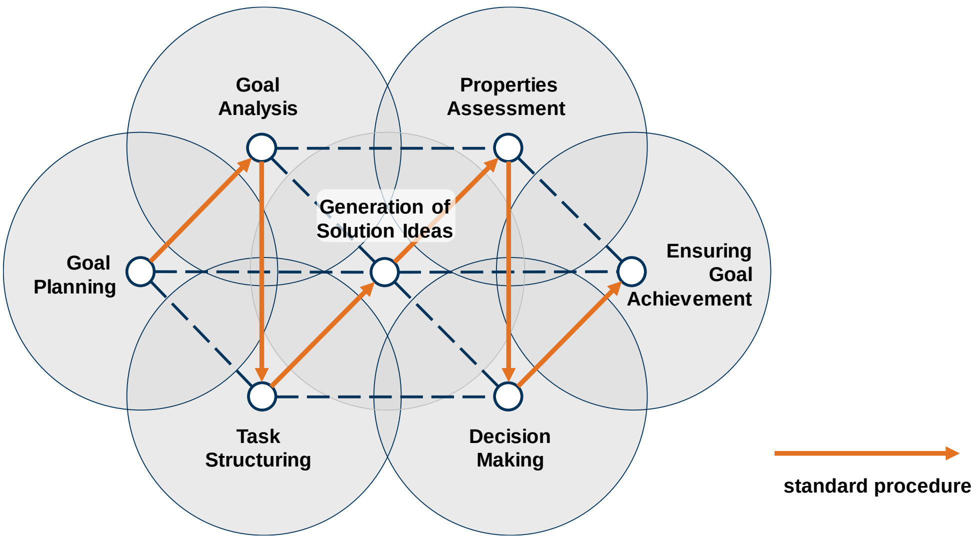

Figure 2-3: Munich Procedure Model (based on: LINDEMANN 2009, p. 47)

The **SPALTEN**[8] methodology is a universal procedural approach for solving problems in different contexts and complexity levels (ALBERS et al. 2005; ALBERS et al. 2016a; ALBERS AND BRAUN 2011, p. 15f). In this respect, product development is considered as a problem solving process on an abstract level. SPALTEN consists of seven steps (ALBERS et al. 2016a, p. 5), as shown in Figure 2-4. The (1) **situation analysis** examines boundary conditions and goal, which is further detailed in the (2) **problem containment** in terms of an analysis of actual and target state, their delta and reasons for this delta. This is the basis for the (3) search for **alternative solutions**. In the (4) **selection of solutions**, this variety of alternative solutions is evaluated, and the best fitting ones are determined. Within the (5) **consequence analysis** potential benefits and risks of the selected solutions are examined, and appropriate risk management measures are planned. Based on this, in step (6) **make decision,** the selected solution alternatives are realised, including project controlling. The step (7) **recapitulate/learn** documents the entire problem solving process and analyses it concerning points for improvements. Due to their modular structure, all steps can be scaled and adapted to the specific context of a project. A particular focus is on documenting (intermediate) results and decisions, a continuous progress control, learning from the current project for future projects and a dynamic evaluation of the team performance and its composition.

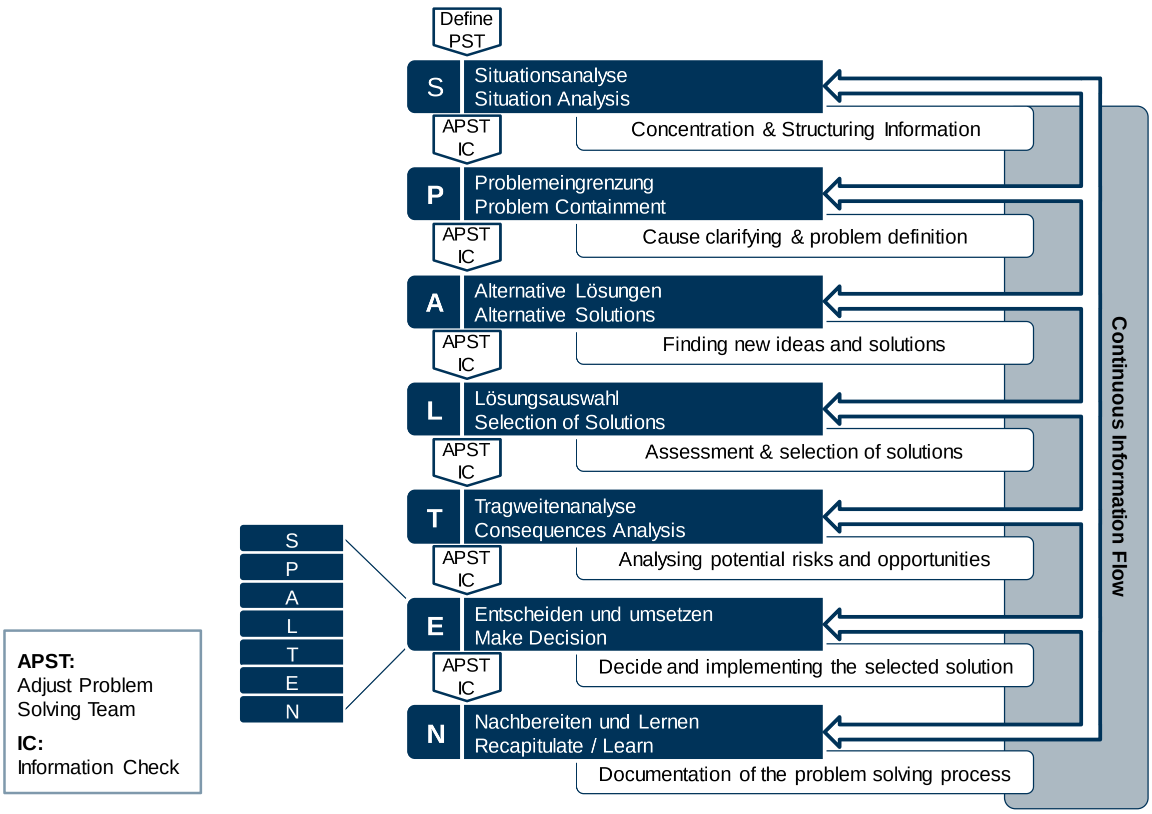

Figure 2-4: SPALTEN Problem Solving Methodology (based on: ALBERS et al. 2016a, p. 5)

[8] It is the German term of *to split and decompose*, and is an acronym of (S) Situationsanalyse, (P) Problemeingrenzung, (A) Alternative Lösungen, (L) Lösungsauswahl, (T) Tragweitenanalyse, (E) Entscheiden und Umsetzen, (N) Nacharbeiten und Lernen (ALBERS et al. 2016a, p. 5).

The **Integrated Product Engineering Model (iPeM)** is a generic modelling framework and product development support for different types of situations, which builds on the SPALTEN model (ALBERS AND BRAUN 2011). Along with engineering elements, it also comprises mental models to support a better understanding of the problem and a better understanding among the designers. As illustrated in Figure 2-5, iPeM links the ***system of objectives*** (definition of development goal and underlying reasons as well as the analysis of requirements and boundary conditions) to the ***system of objects*** (all solutions that solve the defined problem). The connecting element between them is the ***operation system***. The central part of this socio-technical system is the ***activity matrix*** mapping typical ***activities of product engineering*** (such as product planning, validation and market launch) onto the ***activities of problem solving*** (i.e. SPALTEN). Two other key features of iPeM are the ***system of resources*** (which defines all available resources such as methods, tools, machines, employees, time and budget) and the ***phase model***. The latter is a visualisation tool for planning and controlling the activities of the product engineering process. It is comparable to project planning schedules like Gantt charts (cf. PMI 2013, p. 182f) and allows the determination and allocation of activity-specific resources, costs and workloads. iPeM has been continuously enhanced. In its current version, it also comprises elements of *Product Generation Engineering (PGE)* (cf. ALBERS et al. 2016c) to coordinate different product generations. By considering different layers of products and superordinate systems, it integrates process management and engineering design (ALBERS et al. 2016b). Therefore, iPeM is a holistic approach that combines product development support and managerial perspective by defining the superordinate goal, resulting objectives and intended outcomes as well as considering necessary and available resources.

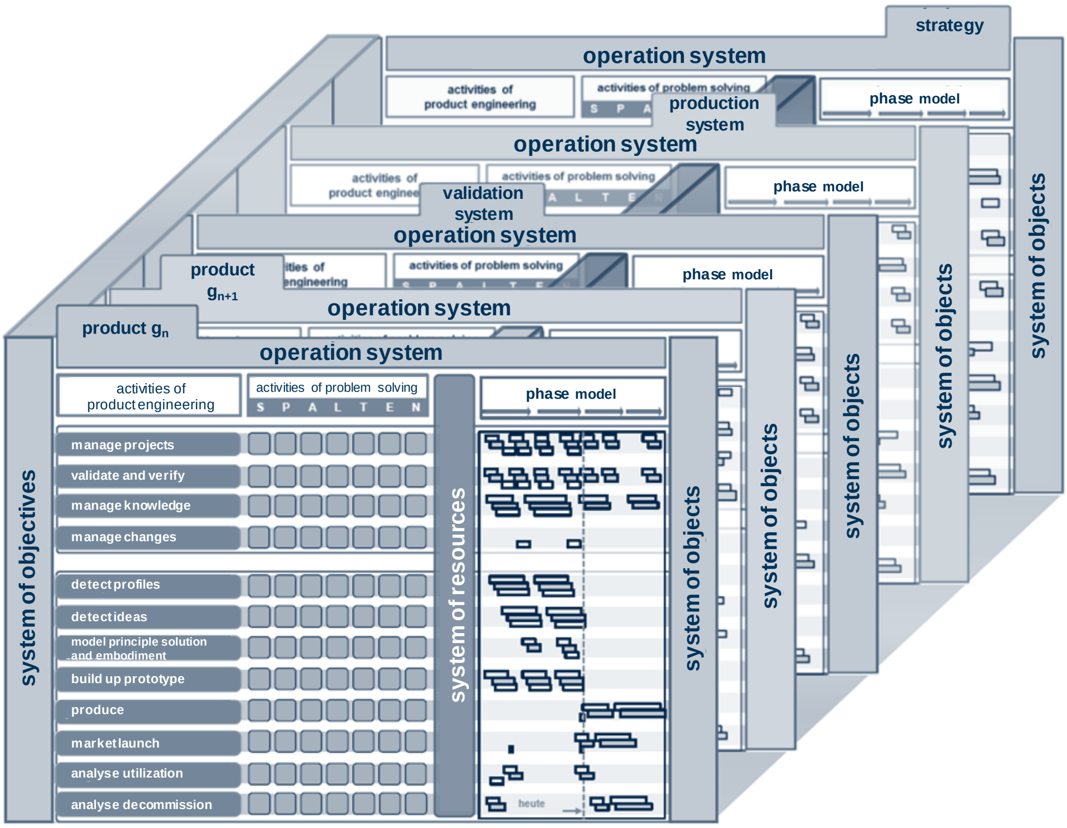

Figure 2-5: The integrated Product engineering Model (iPeM) in the context of PGE (ALBERS et al. 2016b, p. 5)

The **Stage-Gate Model** is an innovation management model, which is based on the finding that many companies (1) start more innovation projects than they can handle, and (2) they often realise too late that projects are not expedient (COOPER 2001; 2007, p. 2f; GASSMANN AND SUTTER 2008, p. 5; LORENZ 2008, p. 34). Therefore, COOPER set up a standardised innovation process, which is structured in five stages and five gates, as shown in Figure 2-6. The ***stages*** represent basic process steps from developing ideas to the commercialising of the final product. The ***gates*** represent defined milestone in the process. Similar to *decision gates* in systems engineering (HASKINS 2006, p. 3.2), they serve as a progress controlling instrument and support the decision either the process can be continued, or should be paused or cancelled. The Stage-Gate Model is a linear and fixed process allowing the timely identification of project deviations and execution of appropriate measures. Downsides are the high coordination effort and the suppression of creativity and innovativeness (LORENZ 2008, p. 67f). To compensate those shortcomings, the model was continuously adapted over the years (COOPER 2014).

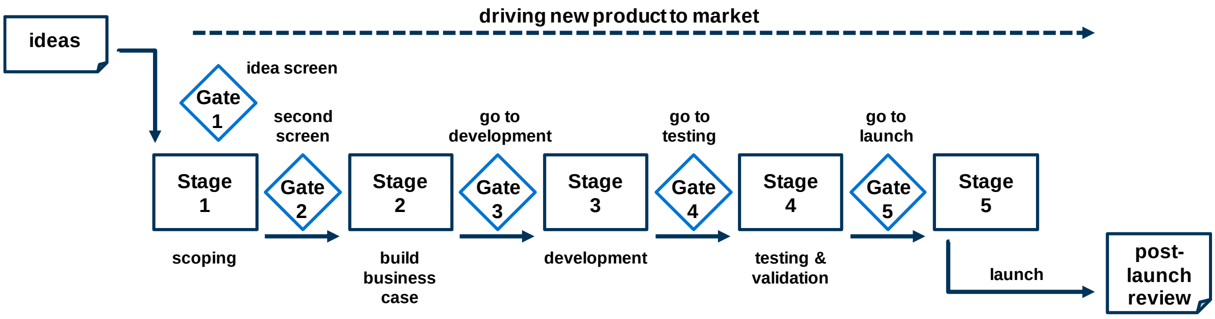

Figure 2-6: Stage-Gate Model (COOPER 2007, p. 2)

2.2.5 Synopsis of product development in innovation management

Product development is the basic element of the innovation process. It comprises all activities from the identification of customer needs and requirement analysis, via the development of alternative solutions to the start of production. The superordinate product engineering process additionally includes the development of production machines and planning of the production process, and is itself part of the larger innovation process. This also comprises preceding strategic phases and succeeding phases such as commercialisation and – in terms of a product life cycle perspective – different after sales phases.

Product development and innovation activities are the result of a joint collaboration of various actors within a socio-technical system. In this regards, companies face increasing challenges by growing degrees of differentiation of labour and complexity of products. Therefore, a sufficient structure and coordination of product development and innovation processes are essential. In particular, agile structures seem to provide advantages over inflexible processes in specific problem areas (GASSMANN 2006, p. 223). In this respect, product development projects are of increasing importance. They also allow explorative innovation activities besides the daily business. Due to their decoupling and closeness they have only a low risk of negative effects in the case of a project failure. To ensure the success of innovation activities, a sufficient planning, execution and controlling is essential. Respective methodical support can range from single methods up to holistic product engineering models.

2.3 Opening up the product development process by Open Innovation

The following chapter introduces the Open Innovation (OI) paradigm, and presents typical OI partners and OI methods as well as potential benefits and risks.

2.3.1 The paradigm of Open Innovation

The relevance of Open Innovation

Product development and innovation projects in general continuously become more complex and fast-paced due to changes of technologies and customer needs (DAHLANDER AND GANN 2010, p. 699; HUIZINGH 2011, p. 2). As a result, knowledge is becoming one of the most important resources of companies (GASSMANN 2006, p. 224). Companies face various challenges due to the fast speed of knowledge growth, global distribution of knowledge, increasing labour division and high mobility of knowledge carriers (DAHLANDER AND GANN 2010, p. 699; GASSMANN 2006, p. 223f; HUIZINGH 2011, p. 2; VAN DE VRANDE et al. 2009, p. 426). Nevertheless, this mobile and distributed knowledge is essential as trigger and source of innovative ideas (BERGMANN et al. 2009, p. 141), along with the fact that innovations are based on interdisciplinary knowledge exchange and collaboration of different knowledge carriers (GASSMANN AND SUTTER 2008, p. 5; HILGERS AND PILLER 2009, p. 5). Nowadays, companies can hardly innovate alone but cooperate with other partners (GERHARDS 2013, p. 20; VAN DE VRANDE et al. 2009, p. 426). A citation that is referred to Bill Joy of Sun Microsystems summarises the issue as: "*No matter who you are, most of the smartest people work for someone else*.".

The involvement of external partners allows better access to valuable knowledge. In this regards, knowledge can be differentiated into (1) **knowledge of needs** that indicate customer needs and expected benefit of the product and therefore influence the effectiveness of the innovation process, and (2) **knowledge for solutions** that increase the efficiency of the innovation process by describing how to realise those needs in a product or process (HILGERS AND PILLER 2009, p. 5f; KIRSCHNER 2012, p. 55; REICHWALD AND PILLER 2009, p. 130). This knowledge can range from ideas to finished products and can originate from different sources, such as science, technology and product development processes (BOGERS AND WEST 2012, p. 65). For a detailed consideration of different knowledge types, dimensions, layers, sources and management, refer to KIRSCHNER (2012, p. 53f), KOHN (2014, p. 79f) and SCHENKL (2015, p. 17f) . An innovation concept, which particularly focusses on knowledge exchange with various external partners, is Open Innovation (OI).

Definition of Open Innovation (OI)

The notion "***Open Innovation***" in its current meaning was introduced by CHESBROUGH (2003b) in terms of opening up a company's innovation process to its environment. While the first definition by CHESBROUGH (2003a, p. xxiv) focus on the need of companies to use internal and external ideas as well as internal and external paths to market, CHESBROUGH et al. (2006, p. 1) and CHESBROUGH AND BOGERS (2014, p. 16) define: "*(...) Open Innovation is the use of*

***purposive inflows and outflows of knowledge** to **accelerate internal innovation**, and expand the markets for **external use of innovation**, respectively.*". However, there is no one and only definition of OI since different authors put varying focusses and perspectives within their definitions. Some of them even mix OI with neighbouring concepts such as user innovation or distributed innovation (cf. BERGMANN et al. 2009; HOSSAIN 2013, p. 31). Detailed overviews of different definitions of OI can be found in BRAUN (2012, p. 4f), GIANIODIS et al. (2010, p. 552), SALVADOR et al. (2013, p. 356) and WEST et al. (2014, p. 806). Nevertheless, a central aspect of all definitions is the equality of internal and external knowledge (cf. CHESBROUGH et al. 2006, p. 1) and the collaboration with external partners (cf. GIANIODIS et al. 2010, p. 531) due to the increasing relevance of search and sourcing of external "*innovative knowledge*" as essential part of innovation management (BOGERS AND WEST 2012, p. 68). Along with knowledge, also the exchange of resources and capabilities is part of OI (GIANIODIS et al. 2010, p. 531). The overall goal of OI is the enhancement of the effectiveness and efficiency of innovation and product development processes in companies (HILGERS AND PILLER 2009, p. 10).

This company focus is also a central distinction from the closely related ***user innovation*** (PILLER AND WEST 2014, p. 30f). User innovation (or also *user-centred innovation*) describes the collaboration and knowledge exchange between individuals and groups of individuals (HIPPEL 2005, p. 1), who aim at solving their and social needs – usually independent from a company and no focus on profits (BOGERS AND WEST 2012, p. 70; PILLER AND WEST 2014, p. 29; WEST et al. 2014, p. 808). The basic working principle is a "*free revealing*" of knowledge (HIPPEL 2005, p. 77) that correlates with "*non-pecuniary revealing*" from OI (DAHLANDER AND GANN 2010, p. 704f)[9]. An exemplary concept is *open source*, where everyone can freely use results from other users (BOGERS AND WEST 2012, p. 67; HIPPEL 2010, p. 555). Strong intellectual property (IP) protection mechanisms are considered as a barrier in this case (BOGERS AND WEST 2012, p. 70; HOSSAIN 2013, p. 31).

As this dissertation aims at supporting companies in improving their innovation performance, it uses the concept of **Open Innovation** as a **firm-centric** type of innovation (PILLER AND WEST 2014, p. 29). In contrast to user innovation, IP protection and its strength play an important role (BOGERS AND WEST 2012, p. 70). Nevertheless, besides monetary forms collaboration, OI also includes non-monetary forms (HILGERS et al. 2011, p. 85). In addition, specific aspects, methodologies and methods like the Lead-User approach are utilised for developing the following OI planning methodology[10].

Novelty and characteristics of Open Innovation

A common critic of Open Innovation (OI) is its novelty and genuineness (TROTT AND HARTMANN 2009), which still need to be discussed and justified even after more than a decade

[9] For more details, refer to the appendix 13.2.1.

[10] Other concepts, such as OI triple helix innovation as combination of academia, industry and government (GIANNOPOULOU et al. 2011, p. 510), quadruple and quintuple helix innovation concepts (CARAYANNIS AND CAMPBELL 2011) or even n-tuple helices (LEYDESDORFF 2012), are not considered within this dissertation.

after its "development" (cf. CHESBROUGH AND BOGERS 2014). In this respect, OI represents a **framework for supporting a purposeful knowledge exchange**.

Despite the claim of being "*the new imperative*" (CHESBROUGH 2003a) or a "*new paradigm*" of innovation management (CHESBROUGH et al. 2006), **OI is not a completely novel concept** (BERGMANN et al. 2009, p. 140; ENKEL 2009, p. 177; HERZOG AND LEKER 2011, p. vii; HUIZINGH 2011, p. 2; SALVADOR et al. 2013, p. 358). Although external collaborations have strongly increased since the 1980s, they also existed before (GASSMANN 2006, p. 223). Some approaches have been applied long before 2003, such as customer and supplier cooperation (AYLEN 2010, p. 77f; ENKEL et al. 2011, p. 1162; GASSMANN 2013, p. 5; THOMAS 1988), global engineering networks (GAUSEMEIER 2006), technology-push concepts (HERSTATT AND LETTL 2004), the Lead-User approach (HIPPEL 1986), antecedents of ideation contests like the "*longitudinal act*" in1714 (GASSMANN 2013, p. 4; MÖSLEIN AND NEYER 2009, p. 94) and collaborative inventions like the development of electric lighting by the Edison's laboratory (DAHLANDER AND GANN 2010, p. 701). The *five step concept generation method* of ULRICH AND EPPINGER (2003, p. 100) also already present an external search path. Even CHESBROUGH (2003a, p. xxvii) mentions decades-old partnerships and alliances in Hollywood's movie industry. WEST et al. (2014, p. 805f) see **three antecedents of OI**: (1) sources of innovative ideas lie outside of companies, (2) commercialisation of innovation efforts within innovation frameworks, and (3) increasing interest in business model innovations and new value chain models in the context of the rise of the internet in the 1990s. Therefore, the term "***Closed Innovation***" by CHESBROUGH (2003a, p. xx)[11] can be rather seen as a theoretical construct for better characterising OI than as a real existing concept (in line with HUIZINGH (2011, p. 2)).

Still, OI is also not only a part of supply chain management (GROEN AND LINTON 2010, p. 554) and not only "*old wine in new bottles*" (TROTT AND HARTMANN 2009). **OI comprises a variety of new characteristics** that distinguish it from traditional concepts of innovation management. OI extends traditional external partners like customers and suppliers by new non-traditional ones, such as universities (HENTTONEN et al. 2015, p. 8; LAZZAROTTI AND PELLEGRINI 2015, p. 196) and experts from other industry sectors (HUIZINGH 2011, p. 5). Knowledge and knowledge carriers are widely distributed and represent a "*global innovation memory*" (GASSMANN 2006, p. 223; MÖSLEIN AND NEYER 2009, p. 99), which allows the involvement of a wide range of different partners (LOREN 2011, p. 7). In particular, increasing industry sector-spanning collaborations offer advantages in terms of combining complementary competences, using synergy potentials and share of risks without a competitive relationship (GASSMANN 2006, p. 224). Along with individuals, single organisations and groups, OI also allows the collaboration with more or less specified crowds (DAHLANDER AND GANN 2010, p. 700f; WEST AND LAKHANI 2008, p. 228).

In general, **external sources of knowledge receive a new strategic focus and relevance** (ENKEL 2009, p. 177). Along with new types of partners, traditional partners play a more active role in the innovation process. By changing from a ***manufacturer-active-paradigm*** to a ***customer-active-paradigm*** (REICHWALD AND PILLER 2009, p. 135f; VOLLMANN et al. 2012, p. 17), customers are no longer passive consumers and feedback providers (BILGRAM et al.

[11] In this case, Chesbrough uses "xx" to indicate the Roman number of 20.

2011, p. 35; GIANNOPOULOU et al. 2011, p. 514; HILGERS AND PILLER 2009, p. 10). They became active innovation partners, who provide knowledge of needs as well as knowledge for solutions. BILGRAM et al. (2011, p. 34) state a particular trend to *participative innovation* in terms of *co-creation*.

The high number of potential OI partners and their **global distribution** require new forms of collaboration (MÖSLEIN AND NEYER 2009, p. 99). Dyadic interactions of two companies are shifting to external networks, innovation ecosystems and communities (FICHTER 2009, p. 357f; LEE et al. 2010, p. 291; MAURER AND VALKENBURG 2011; VANHAVERBEKE 2006; WEST et al. 2014, p. 809). Due to the global distribution of OI partners, internet and web 2.0 technologies, like social media, are of high importance for an efficient collaboration (BILGRAM et al. 2011, p. 35; GASSMANN 2013, p. 4; HILGERS et al. 2011, p. 85). Central aspect of these new information and communication technologies is their interactive character, which allows cooperation between different OI partners (BREUER AND PERREY 2011, p. 20; GASSMANN 2006, p. 223; LINDERMANN et al. 2009, p. 32). OI collaborations also show a high speed of their interactions (MÖSLEIN AND NEYER 2009, p. 99). Along with crowd-focussed online collaboration channels, OI also comprises other forms of collaboration like cross-industry innovations (BRUNSWICKER AND HUTSCHEK 2010; ECHTERHOFF 2014; ENKEL AND HEIL 2014). HILGERS et al. (2011, p. 85) also consider non-monetary forms of collaborations as important feature of OI. These are closely linked to business model innovations (CHIARONI et al. 2010, p. 224; VANHAVERBEKE AND CHESBROUGH 2014, p. 50), which define how companies create and commercialise new value (CHESBROUGH AND ROSENBLOOM 2002, p. 529; PAASI et al. 2010, p. 632).

In summary, **OI is part of a holistic innovation strategy** and concept (HERZOG AND LEKER 2011, p. 22; WEST AND GALLAGHER 2006, p. 320) and enriches traditional innovation activities in companies (ERTL 2010, p. 79). Therefore, **OI represents an integrated innovation framework** that structures existing collaborative innovation and product development approaches, and purposefully derives new approaches, methods and tool.

Internal research and development (R&D) is not replaced by OI (CHESBROUGH AND BRUNSWICKER 2013, p. 23). Instead, **OI is complementary to internal R&D** and **enhances it by external perspectives, knowledge and capabilities** (BILGRAM et al. 2011, p. 40; DRECHSLER AND NATTER 2012, p. 443; SPITHOVEN et al. 2010, p. 377; WEST et al. 2014, p. 805). Internal R&D capabilities and expertise are even essential for assessing, absorbing and operationalising of external knowledge (BRAUN 2012, p. 14; CHESBROUGH 2003a, p. xxvi; DAHLANDER AND GANN 2010, p. 701; SPITHOVEN et al. 2010, p. 377). Companies need competences in fields which are related to their partners, in order to assimilate and further co-develop external ideas internally (DAHLANDER AND GANN 2010, p. 701). In this respect, necessary internal capabilities are summarised by the term "*absorptive capacity*" (COHEN AND LEVINTHAL 1990) that is analysed in more detail, for instance, by BLOHM (2013a).

Although CHESBROUGH (2003b) discovered OI an a **project-level**, academia has been mainly focussing on a firm-level perspective of OI so far (GIANIODIS et al. 2010, p. 553; VANHAVERBEKE et al. 2014, p. 281). This is considered a shortcoming, as innovation activities in companies are usually conducted on a project basis (BRANDT 2004, p. 15; VOS AND ACHTERKAMP 2004, p. 5) due to their higher flexibility and performance (GASSMANN AND

SUTTER 2008, p. 5), as described in chapter 2.2.3. The same applies for OI that is usually applied on a project base (GIANNOPOULOU et al. 2011, p. 513; LOPEZ-VEGA et al. 2016, p. 135). MANOTUNGVORAPUN AND GERDSRI (2015, p. 719) even calls OI a "*project-based, interfirm cooperation*". OI projects also play a particularly important role for first applications and an implementation of OI (BOSCHERINI et al. 2010; CHESBROUGH AND BRUNSWICKER 2013, p. 20; LOREN 2011, p. 14). Projects allow experimenting with OI with limited risks as the OI project is encapsulated and separated from the innovation process (CHIARONI et al. 2010, p. 241). Therefore, in particular methodical support for SMEs without experience with OI should focus on OI projects, which represent a common access path to OI.

Structuring different forms of Open Innovation

OI bears a specific complexity since it affects and combines different research disciplines, and differs from company to company (GASSMANN 2006, p. 224). To allows a systematic and effective utilisation of OI, a corresponding framework is required. However, despite its relevance, such a framework is still missing (BRAUN 2012, p. 3; GASSMANN et al. 2010, p. 216; KAIN 2014, p. 37). Hence, only a fragmented overview exists so far. KAIN (2014, p. 38f) and HOSSAIN (2013, p. 31f) provide a review of different categorisation approaches.

A common categorisation is the differentiation of OI activities based on the **flow of knowledge** (GASSMANN AND ENKEL 2004, p. 10; GIANIODIS et al. 2010, p. 549) that correlates with the **locus of innovation** (CHESBROUGH AND BOGERS 2014, p. 4; CHESBROUGH AND CROWTHER 2006, p. 229). As illustrated in Figure 2-7, ***outside-in (inbound) innovations*** describe a knowledge flow into the company and an enhancement of the internal innovation process. ***Inside-out (outbound) innovations*** represent a knowledge flow from the company to its environment to foster new external innovation or to enter new markets. ***Coupled innovations*** are a combination of the previous forms and can, for instance, be found in R&D cooperation.

Figure 2-7 also indicates that OI is not a binary decision but allows various gradations between closed and open (DRECHSLER AND NATTER 2012, p. 438). To describe this "*continuum of openness*" (HILGERS et al. 2011, p. 85), the term ***permeability*** was introduced (DAHLANDER AND GANN 2010, p. 699; DITTRICH AND DUYSTERS 2007, p. 512; GIANIODIS et al. 2010, p. 553; HUGHES AND WAREHAM 2010, p. 326). HENKEL (2006) and ALEXY et al. (2013) also use the term of ***selective revealing***. Both terms imply that companies need to systematically plan and decide which process phases, which projects and which tasks they like to open for which type of collaboration and external OI partner (cf. BILGRAM et al. 2013). This also implies that OI is not equally suitable for all companies, but depends on factors such as industry (GASSMANN 2006, p. 223), product life cycle phase and position in the supply chain (CHRISTENSEN et al. 2005, p. 1545). DRECHSLER AND NATTER (2012) investigate different drivers of openness and closedness. The differentiation of different levels of openness also serve as basis for alternative categorisation approaches (cf. appendix 13.2.1). In general, these support in characterising the intended OI strategy and OI project in respect to different perspectives. Along with clarifying the superordinate goal of the OI project, the categorisations can serve as framework to derive indications for suitable groups of OI partners and appropriate OI methods. The following **dissertations uses the categorisation** concerning the **direction of knowledge flows**.

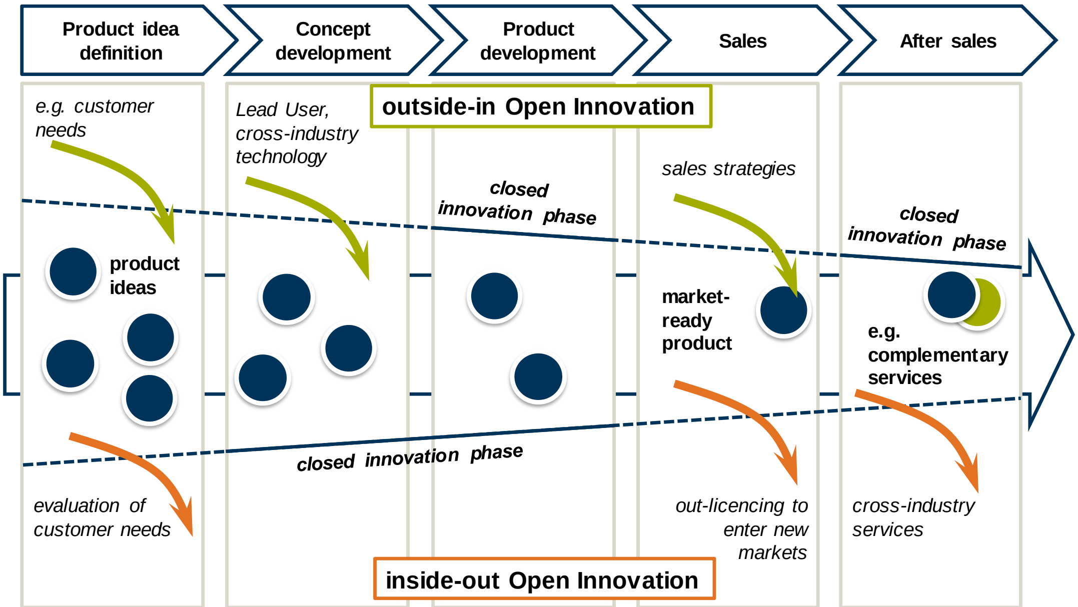

Figure 2-7: Open Innovation – innovation funnel with exemplarily opened phases (GUERTLER AND LINDEMANN 2016b, p. 503)

2.3.2 Typical Open Innovation partners

Innovations are the result of the collaboration of different partners (cf. chapter 2.2.1), which also applies for OI (HILGERS AND PILLER 2009, p. 7; HYLL AND PIPPEL 2016, p. 468). Although OI is often equated with crowdsourcing of customers and users (for instance, REICHWALD AND PILLER (2009, p. 153) or VOLLMANN et al. (2012, p. 19)), OI focusses on various types and groups of potential OI partners. OI partners can be individuals, organisations and groups as well as communities (BERGMANN et al. 2009, p. 146; BOGERS AND WEST 2012, p. 65; DAHLANDER AND GANN 2010, p. 700f; GIANNOPOULOU et al. 2011, p. 514; WEST AND LAKHANI 2008, p. 228). Based on GUERTLER et al. (2013, p. 2), this dissertation defines OI partners as:

"*An Open Innovation partner is any* ***(internal and external) individual, group or organisation*** *that is involved in the Open Innovation project.*".

In this respect, stakeholders (cf. chapter 5.3.3) represent potential OI partners. Along with these "*known*" potential OI partners, companies can also search for new, so far unknown OI partners (cf. GUERTLER AND LINDEMANN 2016a). In general, there are three basic directions of collaboration (ENKEL 2009, p. 184; KERN 2016, p. 459), as depicted in Figure 2-8: (1) **vertical collaborations** alongside the value chain, (2) **horizontal collaborations** within one stage of the value chain, and (3) **industry-spanning collaborations** with OI partners from other industry sectors.

Although the most frequently involved OI partners are still customers, suppliers and universities (CHESBROUGH AND BRUNSWICKER 2013, p. 2), there is a broad variety of different types of OI partners, as also illustrated in Figure 2-8. Table 13-1 provides a broader overview of typical OI partners in literature (appendix 13.2.2).

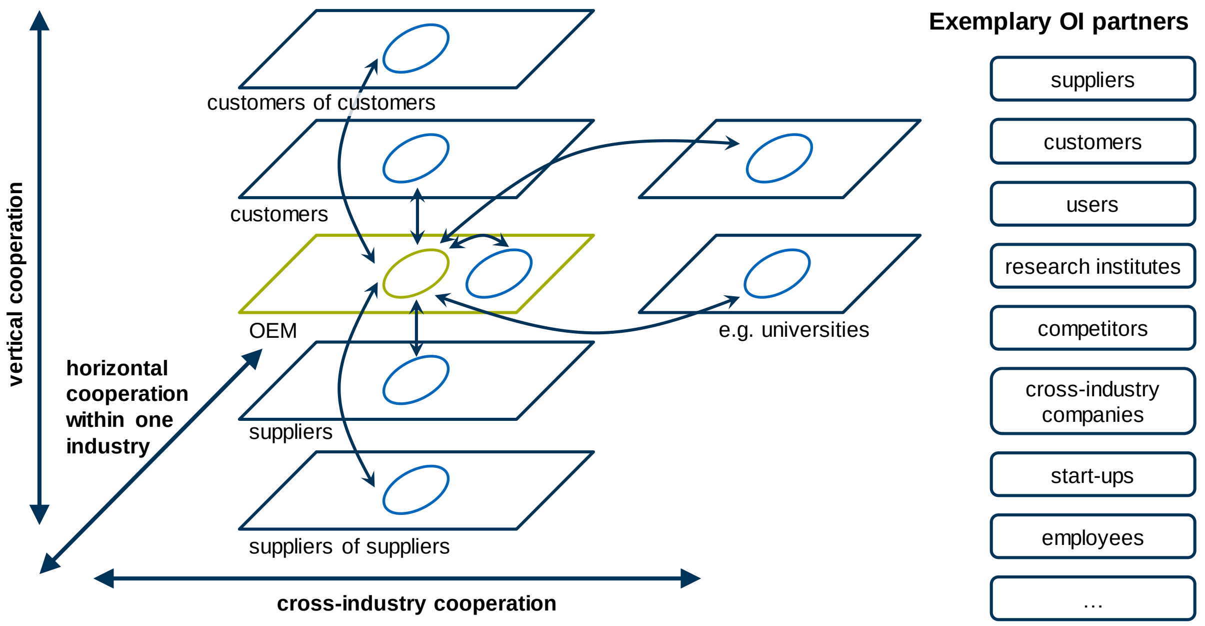

Figure 2-8: Different perspectives of OI partners (adapted from: ENKEL 2009, p. 184)

2.3.3 Traditional Open Innovation collaboration methods

OI collaboration methods[12] allow the efficient knowledge exchange with external and internal OI partners. The following section gives an overview of 12 established OI methods, which are considered within this dissertation. They differ, for instance, in terms of the size of the involved OI partners and their need of interaction with OI partners. A detailed characterisation of each OI method is presented in the appendix 13.5, based on the method profiles of SAUCKEN et al. (2015).

- **Ideation contest (idea contest)**: This OI method focusses on gaining a high quantity of innovative ideas or solution concepts by a crowd of OI partners. A task for solving a particular problem is published to the public and invites OI partners to submit related ideas within a specific timeframe (BELZ et al. 2009, p. 12f; BLOHM 2013b, p. 25f; DIENER AND PILLER 2009, p. 18f; WALCHER 2007, p. 39). In addition, OI partners can also rate and comment on existing ideas of other OI partners, and use them as basis for new ideas. The best ideas are rewarded in the end (HILGERS AND PILLER 2009, p. 7; REICHWALD AND PILLER 2009, p. 197f; WENGER 2014, p. 1f). Along with the generation of innovative ideas and solution concepts, ideation contests also allow the identification of outstanding participants, who can be purposefully recruited (EBNER et al. 2009, p. 353).
- **Ideation platform (idea platform)**: Ideation contest and platform are relatively similar. In contrast to an ideation contest, platforms are usually not bound to a specific timeframe and allow a continuous and self-initiated submission of ideas by OI partners

[12] Sometimes also called *OI instruments* (cf. MÖSLEIN AND NEYER 2009, p. 93).

(KAPLAN AND HAENLEIN 2010, p. 61f; REICHWALD AND PILLER 2009, p. 197f). A specific type of an ideation platform is an "*innovation market places*", which is run by an OI intermediary, that supports companies in using the platform (MÖSLEIN AND NEYER 2009, p. 95).

- **(Problem) Broadcasting**: Similar to idea contest and platform, a task is published to public or a specific pool of problem solvers. However, in contrast to the previous OI methods, usually an interaction among partners is not supported since they send their ideas and solutions to a specific mailbox (DIENER AND PILLER 2009, p. 18f; 2010, p. 95f). This is particularly an advantage for secrecy-sensible topics.
- **Community for OI**: A community is an informal association of individuals, who are interested or affected by a specific topic or product. The community's origin can be self-induced or induced by a company (BLOHM 2013b, p. 27f; FICHTER 2009, p. 358f). By bringing together different individuals and fostering their discussion, they provide insights in user needs, and collaboratively developed ideas and solution concepts for specific problems (HILGERS AND PILLER 2009, p. 6f; MÖSLEIN AND NEYER 2009, p. 96).
- **Netnography**: The term is a combination of "*internet*" and "*ethnography*", and describes the combination of qualitative empathic research methodologies and adapted ethnographic research techniques (BILGRAM et al. 2011, p. 36). Based on an existing community, netnography supports in systematically analysing current discussion topics and interactions of community users (BELZ AND BAUMBACH 2010, p. 305f; KOZINETS 2002, p. 63f). This allows the identification of relevant needs of the community and initial solution ideas as well as outstanding users. Due to a usually non-interaction-based observation of the community, netnography is suitable for secrecy-sensible and PR-sensible topics (LANGER AND BECKMAN 2005, p. 189f).
- **Lead-User approach**: Lead-Users have relevant needs long before the majority of other users. They also have the motivation and expertise to contribute to a respective solution (DIENER AND PILLER 2009, p. 10f; 2010, p. 96f; HIPPEL 1986; REICHWALD AND PILLER 2009, p. 180f; WALCHER 2007, p. 30). Hence, their identification and involvement as OI partners offer essential competitive advantages to companies. After their identification, the collaboration with Lead-Users usually takes place within specific workshops (BLOHM 2013b, p. 22f; HILGERS AND PILLER 2009, p. 6).
- **Immersive Product Improvement (IPI)**: It provides a structured and controlled feedback channel to users of a specific product. The OI method can be applied directly with a physical product or online with a graphical representation of the product. It allows users to specifically mark and comment on positive and negative aspects of the product. In addition, they can also evaluate existing comments of other users as well as submit ideas for solving identified shortcomings or general improvements of the product. (KIRSCHNER et al. 2011, p. 298f; KIRSCHNER 2012, p. 121f)
- **Toolkits for user innovation (early phases)**: They can be considered as very limited CAD tools, which allow OI partners to create and play with own designs of their "perfect" product. By visualising and experimenting with the virtual product, *tacit* or

implicit user needs can be revealed (BLOHM 2013b, p. 24; DIENER AND PILLER 2009, p. 17; 2010, p. 93; MÖSLEIN AND NEYER 2009, p. 97; REICHWALD AND PILLER 2009, p. 189f). In addition to the generation of innovative ideas and identification of user needs, toolkits can also increase customer loyalty (PILLER AND WALCHER 2006, p. 315).

- **Toolkits for user co-design (late phases)**: In a later innovation phase, toolkits can also be used in the context of mass customisation (BLOHM 2013b, p. 25; DIENER AND PILLER 2009, p. 18; HILGERS AND PILLER 2009, p. 6; KAMIS et al. 2008, p. 160; REICHWALD AND PILLER 2009, p. 193; ROTH et al. 2015b). In this respect, toolkits offer a broader solution space than traditional configurators, which only allow the combination of already existing component variants. Toolkits allow the development of individual components and products within specifically defined design spaces.
- **Cross-Industry Innovation (CII)**: CII allows the systematic identification and adaption of existing solution concepts from other industry sectors to solve a specific problem within the own industry. By using established solution concepts, the risk of failures and time to market can be reduced whereas the innovativeness of the resulting product can be increased (BRUNSWICKER AND HUTSCHEK 2010, p. 686f; ECHTERHOFF 2014, p. 22f; ENKEL AND GASSMANN 2010, p. 256f; FRANKE et al. 2014, p. 1063f). However, due to the different application contexts, solutions cannot be applied directly but have to be adapted accordingly (ROTH et al. 2015a, p. 292).
- **University cooperation**: The collaboration with researchers and students at universities or research centres allows access to current research topics as well as new technologies and approaches (FABRIZIO 2006, p. 134f; LIND et al. 2013, p. 86f; PHILBIN 2008, p. 488f). In addition, it also opens access to a pool of young unconventional thinking and creative people.
- **OI intermediary**: As a combination of consultant and service provider, OI intermediaries support companies without experience with OI in planning, executing and exploiting an OI project (ALBERS et al. 2014b, p. 485f; DIENER AND PILLER 2009, p. 23f; 2010, p. 105f; GASSMANN et al. 2011, p. 459; JANSSEN et al. 2014, p. 3).

2.3.4 Potential benefits and risks of Open Innovation

Benefits of Open Innovation

In general, OI has a positive effect on a company's **innovation performance** (HUIZINGH 2011, p. 4) by utilising external expertise and knowledge, by accessing a broad pool of innovative ideas and capabilities (DRECHSLER AND NATTER 2012, p. 443; LOREN 2011, p. 7) and by resolving a lack of resources (GASSMANN AND ENKEL 2004, p. 1).

In particular from an economic perspective, OI can **reduce R&D costs** and cost-to-market (GASSMANN AND ENKEL 2004, p. 1; HILGERS AND PILLER 2009, p. 10; HUIZINGH 2011, p. 4; ILI AND ALBERS 2010, p. 46; REICHWALD AND PILLER 2009, p. 172; VOLLMANN et al. 2012, p. 20), reduce capital needs (ILI AND ALBERS 2010, p. 47) and **increase sales**, for instance, by exploiting new markets (HUIZINGH 2011, p. 4; VANHAVERBEKE et al. 2008, p. 254).

In respect to the product development process, OI can **shorten the time-to-market** (DRECHSLER AND NATTER 2012, p. 443; GASSMANN AND ENKEL 2004, p. 1; HILGERS AND PILLER 2009, p. 10; HUIZINGH 2011, p. 4; ILI AND ALBERS 2010, p. 46; REICHWALD AND PILLER 2009, p. 172; VOLLMANN et al. 2012, p. 19). It allows the utilisation of complementary competences (GASSMANN 2006, p. 224) and can leverage investments in internal R&D by combining expertise from different departments (DAHLANDER AND GANN 2010, p. 699).

Inventions themselves can benefit by a **higher innovativeness** (HUIZINGH 2011, p. 4; REICHWALD AND PILLER 2009, p. 173) as OI supports more radical innovations (GASSMANN 2006, p. 223; VOLLMANN et al. 2012, p. 22) by accessing a larger pool of ideas (ILI AND ALBERS 2010, p. 47) and new scientific achievements (VANHAVERBEKE et al. 2008, p. 253). OI also allows time and development advantages due to the exclusivity of new insight from early involvements of external actors and new technologies (ILI AND ALBERS 2010, p. 46). **Product development risks** can be limited (GASSMANN 2006, p. 224), for instance, by adapting existing solutions from other industry sectors (ECHTERHOFF 2014, p. 6; HILGERS AND PILLER 2009, p. 6; ILI AND ALBERS 2010, p. 47). In addition, OI supports in **avoiding fixations** to existing solutions ("*local search bias*") and organisational blindness (HILGERS AND PILLER 2009, p. 6; ILI AND ALBERS 2010, p. 46; LOPEZ-VEGA et al. 2016, p. 125) by involving an external perspective and unconventional thinkers (GASSMANN AND SUTTER 2008, p. 6). This results in an **increased fit-to-market** of products (HILGERS AND PILLER 2009, p. 10; REICHWALD AND PILLER 2009, p. 172; VOLLMANN et al. 2012, p. 21).

In terms of company strategy and organisation, OI can exploit new business areas and open access to qualified employees (ILI AND ALBERS 2010, p. 47). It also supports in better assessing the value of an innovation and clarifying the core competences of a company (HUIZINGH 2011, p. 4).

Challenges and risks of Open Innovation

However, along with potential benefits, OI also bears its specific risks, which result from the intensified collaboration with external partners and which have to be considered (LEE et al. 2010, p. 291). In the following, they are examined in more details since they indicate **potential needs for further improvements** of OI and according methodical support (chapter 3). In general, the opening of the innovation process imposes new requirements on managing and controlling the innovation process and project since they are more exposed to dynamic influences of the business environment (BERGMANN et al. 2009, p. 141). Innovation performance can be affected negatively when the level of openness is not appropriate (LAURSEN AND SALTER 2006, p. 146).

GUERTLER et al. (2015d) provide a systematic overview and analysis of different barriers and risks that result from opening the innovation process and exchanging knowledge with external partners. The results correlates with findings of other studies, for instance, ALBERS et al. (2014b, p. 487f). Based on a literature review, 12 risk clusters were identified, as shown in Table 2-1 (GUERTLER et al. 2015d, p. 3f):

Table 2-1: Clusters of OI risks (GUERTLER et al. 2015d, p. 3f)

Risk cluster	Description and possible reasons
Uncontrolled knowledge drain	e.g. due to OI partners stealing knowledge or due to a company needing to publish internal knowledge to enable an OI method
IP and Law	e.g. due to shared IP ownerships or internationally varying laws
Benefit-cost ratio	e.g. due to limitations to incremental or short-termed innovations
No suitable OI partners	e.g. due to selecting not suitable OI partners or missing relevant ones
Increased complexity	e.g. due to more communication and interfaces or missing guidelines
Dependence on OI partners	e.g. due to delegating specific tasks to OI partners
Collaboration and organisational barriers	e.g. due to global distribution of OI partners or wrong type of collaboration
Increased competition or competitive disadvantages	e.g. due to entering a new market
Operational risks	e.g. due to a lack of resources or management support
Communication and cultural barriers	e.g. due to cultural clash or inadequate expectations
Incentives (internal and external actors)	e.g. due to missing motivation or resistance to change
Strategic risks	e.g. due to a wrong degree of openness or over-/underestimation of OI

In total, 55 risk-elements could be identified within the 12 clusters. A structural analysis of influence dependencies between these risk elements and a subsequent ABC-analysis of the resulting activities and criticalities revealed the following most relevant risks (cf. appendix 13.7.5 and GUERTLER et al. 2015d): (L.2) *Wrong decisions in OI planning*, (A.3) *Fear of knowledge drain*, (K.3) *Resistance to change*, (I.5) *Missing management support*, (A.2) *Knowledge drain*, (J.1) *Misunderstandings between OI partners*, (K.1) *Missing motivation from OI partners*, (L.3) *Wrong degree of openness*, (A.1) *Knowledge drain by collaboration*, (G.1) *Wrong cooperation type with OI partners*, and (D.2) *Suitable OI partners not selected*.

In addition, the following risks show a high activity and represent sources of other risks: (I.6) *Lack of experience with OI*, (G.4) *Global distribution of OI partners*, and (B.4) *International differences in laws and regulations*.

Central risks are related to **missing experience with OI** and **mistakes when planning OI projects**. Another main risk of opening an innovation process is uncontrolled knowledge drain and exploitation by disloyal OI partners (DAHLANDER AND GANN 2010, p. 699; PAASI et al. 2010, p. 633). However, often this threat is overrated, and the fear of knowledge drain hinders an effective application of OI, which is in line with the findings of SPITHOVEN et al. (2010, p. 378) and GUERTLER et al. (2014b, p. 1027). Otherwise, external knowledge is often considered a threat itself by internal stakeholders since employees fear to be substituted by OI, or they value it lower than own inventions (cf. ***Not-Invented-Here (NIH) syndrome***) (CHIARONI et al. 2010, p. 224; HOSSAIN 2013, p. 35; KATZ AND ALLEN 1982; LOREN 2011, p. 8). Along with knowledge drain, internal and external knowledge can get mixed. In the worst case, the OI partner gets the impression of having essentially contributed to an invention, although the regarding knowledge was already known in the company in advance but not accordingly documented and clarified (PAASI et al. 2010, p. 633).

In this respect, the selection of suitable OI partners plays an important role. In accordance with the structural relevance of the corresponding risk-elements, HYLL AND PIPPEL (2016) particularly analysed the interrelationship between partner types and resulting innovation failures. Although their dataset and therefore the validity of their results are limited[13], they provide some indications: product and process innovation projects seem to be differently affected by varying partner types. Universities seem to have a negative effect on the success of product innovation projects but a positive one on process innovation projects. Suppliers seem to increase the failure probability of both, project and process innovations; competitors only the failure of process innovations.

2.3.5 Summary of Open Innovation in the context of this thesis

OI provides various potential benefits to companies. In the context of this dissertation, this relatively broad definition[14] of CHESBROUGH et al. (2006, p. 1) is used. OI represents an innovation management framework for structuring traditional and new types of collaboration and external partners. Therefore, OI directly builds on established concepts from product development, such as integrated product engineering (ALBERS AND BRAUN 2011; EHRLENSPIEL AND MEERKAMM 2013) and systems engineering (DAENZER AND HUBER 2002; HASKINS 2006; SCHULZE 2016). Due to the focus on a company, and its innovative and economic success, the concept of user innovation (HIPPEL 2005, p. 1) with its focus on free non-pecuniary exchange of knowledge plays only a minor role. Nevertheless, specific aspects are still relevant for OI, such as Lead-User workshops and corresponding identification methods. Although, OI is often considered a synonym of crowdsourcing, for instance GASSMANN (2013, p. 5), this dissertation also focusses on individuals, organisations and groups of them. In addition to traditional partners, such as suppliers and customers, OI supports in methodically involving new partners and broaden the focus beyond the *usual suspects*. In general, all different OI partners show a more active and innovative role than in previous innovation management concepts (KIRSCHNER 2012, p. 34; REICHWALD AND PILLER 2009, p. 127; VOLLMANN et al. 2012, p. 17). Despite this new relevance of external OI partners, it is also crucial to combine external and internal knowledge and OI partners (GIANNOPOULOU et al. 2011, p. 516). In particular OI projects are an important and common way of organising and applying OI in companies (GIANNOPOULOU et al. 2011, p. 513; LOPEZ-VEGA et al. 2016, p. 135; MANOTUNGVORAPUN AND GERDSRI 2015, p. 719). In particularly for first steps with OI, projects offer the advantage of encapsulated risks that are separated from the main innovation process (BOSCHERINI et al. 2010; CHIARONI et al. 2010, p. 241). Therefore, analysing OI on a project-level is particularly relevant.

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[13] Their analysis focusses on a company level. There is neither information about the number of OI projects in general and of failed ones in particular nor about a direct link between partner types and failed projects.

[14] "*(…) Open Innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively.*" (CHESBROUGH et al. 2006, p. 1)

2.4 Open Innovation for product development in SMEs

The following chapter analyses the relevance of **Small and Medium-sized Enterprises (SMEs)** with a particular focus on **German Mittelstand enterprises (also middle sized enterprises)** as special group of SMEs. The chapter also analyses their characteristics and differences from large enterprises as well as specific success factors and barriers for the application of OI. As shown in the following, Mittelstand enterprises and SMEs are not completely identical but show a high level of similarities. Therefore, both terms along with the combined term **Mittelstand enterprise** are used as synonyms in this dissertation.

2.4.1 Economic and technological relevance of SMEs

SMEs are of high importance to the economy of Germany and the European Union in general (cf. chapter 1). Due to representing the majority of companies and employing the majority of employees (IFM BONN 2012; PFOHL 2013), they are considered the "*backbone of the German economy*" (WELTER et al. 2015, p. 1). In an international context, SMEs or family firms are also seen as the "*backbone of corporate life across nations*" (KRAUS et al. 2011, p. 33; RAHMAN AND RAMOS 2013, p. 434). They represent two third of the worldwide companies (KRAUS et al. 2011, p. 33) and are the "*key source of new product development, innovation and new technologies*" (HENRY AND WYNARCZYK 2013, p. 261). Thus, it is of high relevance to support SMEs in maintaining and increasing their innovativeness and economic strength. To support them in a suitable way, firstly their specific characteristics and needs have to be understood.

In general, **SMEs differ from large managers-led enterprises** (also called ***Multi-National Enterprises* (MNEs)**) or as WELSH AND WHITE (1981, p. 18) state: "*A small business is not a little big business*". Due to differing innovation processes of SMEs and MNEs (VOSSEN 1998, p. 88f), OI also differs in both types of companies (BRUNSWICKER AND VANHAVERBEKE 2015, p. 1243; LEE et al. 2010, p. 291; SPITHOVEN et al. 2013, p. 556). The structure and success of innovation management strongly depend on applied strategies and methods as well as context factors, i.e. enablers, barriers and resistance to innovations (MEYER 2013, p. 234). In respect to the overall focus of this dissertation, HOSSAIN (2013, p. 36) even indicates that OI strategies of MNEs are most likely not suitable for SMEs. Therefore, it is necessary to analyse the characteristics of SMEs in contrast to MNEs to allow a purposeful development of suitable methodical support in the following chapters (cf. PFOHL 2013, p. 2f).

In the following, different established definitions of SMEs and synonyms are analysed and consolidated to a consistent definition within this dissertation. Along with this, an analysis of characteristics of SMEs allows a better differentiation from MNEs. The subsequent analysis of OI application in SMEs derives OI-specific success factors and barriers.

2.4.2 Definition of SMEs within this thesis

Despite their economic relevance, a consistent definition of SMEs and Mittelstand enterprises is missing (GÜNTERBERG 2012, p. 174; SPITHOVEN et al. 2013, p. 557). Usually quantitative and qualitative characteristics are mixed (HELTEN 2014, p. 78). Business and economic dynamics, and regional differences make a global definition and characterisation even more challenging (PFOHL 2013, p. 4). HELTEN (2014, p. 78f) distinguishes between two general approaches of characterisation: quantitative and qualitative ones.

Quantitative definition and characterisation

The definition of SMEs is mainly used for governmental funding issues (HELTEN 2014, p. 79). Based on the **European Commission** recommendation 2003/361/EG, companies are characterised concerning their (1) **number of employees**, (2) **annual turnover** and (3) **annual balance sheet total** (GÜNTERBERG 2012, p. 174). SMEs can be distinguished in micro, small and medium-sized enterprises. Companies with more than 249 employees and more than 50 million Euro turnover or 43 million Euro balance sheet total are defined as large scale enterprises.

The **Institut für Mittelstandsforschung Bonn (IfM Bonn)**[15] provide a slightly broader definition (GÜNTERBERG 2012, p. 174) based on only two characteristics, (1) **number of employees** and (2) **annual turnover**, they define small and medium-sized enterprises. In this case, the upper limit of SMEs are maximum 500 employees and maximum 50 million Euro.

However, both definitions show the shortcoming of excluding the majority of German Mittelstand enterprises due to their higher number of employees and annual turnover. HELTEN (2014, p. 79) states that the specific features of Mittelstand enterprises are rather due to qualitative characteristics than due to quantitative criteria. Therefore, many researchers favour a qualitative definition.

Qualitative definition and characterisation

The central aspects of Mittelstand enterprises is an entrepreneur, often also an entrepreneur's family, and their personality (AHSEN et al. 2010, p. 4; BERGHOFF 2006, p. 271) as well as the unity of company, property, risk, control and management (SCHAUF 2009, p. 8). In accordance to this, the IfM Bonn (cf. WELTER et al. 2015, p. 4) defines Mittelstand enterprises independently from their size as companies where:

- **Up to two natural persons** or their family members hold at least 50% of the shares of a company (directly or indirectly), and
- these natural persons are **part of the management**

Additionally, GOEKE (2008, p. 11) still states two quantitative limits, albeit higher than those for usual SMEs:

- number of employees is **maximum 2,500 employees**
- annual turnover is **maximum 500 million Euro**[16]

[15] The *Institut für Mittelstandsforschung Bonn (IfM Bonn)* is a leading research institute that analyses economic, technological and political situation, development and needs of SMEs and Mittelstand companies. It is a foundation of private law. (http://en.ifm-bonn.org)

[16] This is in consistence with KFW (2006, p. 3; 2015, p. 23).

According to IFM BONN (2016) and in line with other authors, such as BERGHOFF (2006, p. 271) and KRAUS et al. (2011), the following terms are synonyms to Mittelstand enterprises:

- In German: *Deutscher Mittelstand, Familienunternehmen, familiengeführtes Unternehmen, Eigentümerunternehmen*
- In English: *German Mittelstand, middle class, family firm. family enterprise, owner's enterprise and family-controlled enterprises*

In this respect, it is relevant that general SMEs and family firms, respectively Mittelstand enterprises, are not automatically identical as there are also non-family SMEs (CASSIA et al. 2012, p. 225). However, there is a large overlap as the majority of SMEs belongs to the Mittelstand enterprises (WELTER et al. 2014b, p. 17). **Therefore, this dissertation considers these terms as synonyms but primarily uses "SMEs"**.

A special type of Mittelstand enterprises are the so called ***Hidden Champions*** that belong to the worldwide TOP-3 companies within their industry or are the number one on a continent, but are almost unknown in the public awareness (KRIZ et al. 2015; SIMON 2013, p. 62). They are particularly innovative and focussed on growth and market leadership. Although, they play an important role in German economy, they are not considered in more detail as **this dissertation aims at providing methodical support for all SMEs**, including Mittelstand enterprises and hidden champions.

Figure 2-9 summarises the different definitions of Mittelstand enterprises. In addition, it also comprises important qualitative characteristics, which are described in the following chapter.

Quantitative definition: **Small and Medium-sized Enterprises (SME)**

European Commission (CSES 2012, p. 8)

	Staff Headcount	Annual turnover		Balance sheet total
Micro	< 10	≤ 2 mil €	OR	≤ 2 mil €
Small	< 50	≤ 10 mil €	OR	≤ 10 mil €
Medium	< 250	≤ 50 mil €	OR	≤ 43 mil €

Institut für Mittelstandsforschung Bonn (IfM Bonn) (GÜNTERBERG 2012, p. 175)

	Staff Headcount		Annual turnover
Small	< 10	AND	≤ 1 mil €
Medium	< 500	AND	≤ 50 mil €
SME in general	< 500	AND	≤ 50 mil €

Qualitative definition: **German Mittelstand / Middle Class / Family Firm**

Institut für Mittelstandsforschung Bonn (IfM Bonn)

- Up to two natural persons or their family members hold at least 50% of the shares of a company (directly or indirectly)
- These natural persons are part of the management.

(WELTER et al. 2015, p. 4)

AND

KfW Bankengruppe (KfW Group)

- Staff headcount: < 2,500
- Annual turnover: < 500 mil €

(GOEKE 2008, p. 11)

Qualitative characteristics

- Unity of company, ownership, risk, control and management
- Personality of entrepreneur shapes company
- Flat hierarchies and direct collaboration between management and employees
- Flexible and fast reaction to changing environment
- Strong social ties to employees
- Decisions often personality- and experience-driven

- Lower financial and personal resources
- Less opportunities to compensate mis-determinations, mistakes and failures
- Lower usage of formal tools for planning and controlling decision supports
- Lower experience with methodical approaches
- Business connections are usually trust-based

(various sources)

Figure 2-9: Overview of quantitative and qualitative definitions of SMEs (enhancement of: HELTEN 2014, p. 81)

2.4.3 Characteristics of German Mittelstand enterprises

The previous chapter presented a quantitative definition of SMEs and differentiation from large multinational enterprises (MNEs). Nevertheless, GOEKE (2008, p. 11) states that quantitative criteria are not sufficient to characterise SMEs. Therefore, it is necessary to analyse qualitative characteristics in more detail in the following (SCHWAB et al. 2011, p. 5).

The central element of SMEs is the **entrepreneur and/or his family**, who own the company, and are responsible and liable for its success and failures (GOEKE 2008, p. 12; HAMER 2013, p. 32; SCHAUF 2009, p. 8; SCHWAB et al. 2011, p. 5). They usually manage the company and strongly shape the company by their **personal values and visions** (AHSEN et al. 2010, p. 4; CASSIA et al. 2012, p. 199; DAWSON AND MUSSOLINO 2014, p. 180; HAMER 2013, p. 32). Strategic goals are mainly influenced by strategies, intensions and motives of the entrepreneur and his family (LAZZAROTTI AND PELLEGRINI 2015, p. 185). This leads to **long-term oriented decisions and planning horizons**, that are not affected by short-term quarterly reports (ALBERTI AND PIZZURNO 2013, p. 143). A **trans-generational vision** of the entrepreneur family provides additional stability, along with a company culture of trust, loyalty and identification with the company (DAWSON AND MUSSOLINO 2014, p. 180). In return, the entrepreneur and his family strongly identify themselves with the company (DAWSON AND MUSSOLINO 2014, p. 180). This and personal liabilities result in a **strong need for independence** (SCHAUF 2009, p. 8), a great aversion to take risks, loose control (ALBERTI AND PIZZURNO 2013, p. 143; SCHWAB et al. 2011, p. 5) and to get dependent on external partners (SPITHOVEN et al. 2013, p. 555). Entrepreneurs strongly affect strength and success of their company (HAMER 2013, p. 32f; SCHWAB et al. 2011, p. 5). This has the advantage that entrepreneurs can usually freely make their business decisions (HAMER 2013, p. 33). **Innovation management** is also often a matter of the entrepreneur himself. He acts as a power promotor and ensures the necessary strategic support of innovation projects (MEYER 2013, p. 236). The downsides are the risk of illness, age and changing preferences, and his often only limited managerial skills (PFOHL AND ARNOLD 2006, p. 18).

Due to the entrepreneur's endeavour to **entrepreneurial freedom**, SMEs are independent companies (WELTER et al. 2014b, p. 17). They show flat hierarchies and a close collaboration between management and employees (HELTEN 2014, p. 80; SCHAUF 2009, p. 8). Internal communication is effective due to short ways of information and decision chains (PFOHL AND ARNOLD 2006, p. 19; VOSSEN 1998, p. 90). In general, processes, organisation and control are more efficient, which results in a higher development efficiency than in MNEs. SMEs are also able to quickly adapt their processes to changing market environments and adopt new concepts (HELTEN 2014, p. 80; PFOHL AND ARNOLD 2006, p. 19f; VOSSEN 1998, p. 90).

This is also partly due to the **employees** of SMEs who usually show **high motivation and engagement** (MEYER 2013, p. 220; VOSSEN 1998, p. 90). The satisfaction of employees and work climate are positive. Central reasons for working in a SME are a **long-term employment** and appreciation of individual achievements by colleagues, who consider themselves a team (HAMER 2013, p. 33). Although a lack of specialisation of employees leads to a diversified and interesting field of activities, it can also result in an accumulation of tasks and overextension of employees (KRÄMER 2009, p. 215; PFOHL AND ARNOLD 2006, p. 19). Employees in SMEs often show **reluctance towards alternations** of processes and technologies (MEYER 2013, p. 239).

Access to new, young and innovative employees is often challenging due to the **decentral and regional distribution** of SMEs, often remote from industrial centres and main cities that provide a pool of skilled workers (SIMON 2013, p. 60). These would be beneficial since SMEs have the disadvantage of their organisational structure, that has only a limited number of departments, which makes it difficult to hold all required product development competences within the company (KRÄMER 2009, p. 214f). As a result, although SMEs have a higher product development efficiency, MNEs have better effects of scales (VOSSEN 1998, p. 90).

Along with employees, a major challenge for SMEs is their **limited pool of resources**, such as budgets and available time (AHSEN et al. 2010, p. 4; MEYER 2005, p. 292; SPITHOVEN et al. 2013, p. 555). This leads to the financing of innovation projects from internal budgets and negative effects onto the innovation capacities (HELTEN 2014, p. 80). It also bears extensive company-spanning consequences of project failures since governmental support in crises is limited (PFOHL AND ARNOLD 2006, p. 19f). As a result of this lack of resources, SMEs are forced to quickly generate revenue from inventions (MEYER 2013, p. 240). This leads to a **prioritisation of daily business** (MEYER 2013, p. 236), and reduced capacities and willingness to develop radical innovations instead of relying on known technologies (ALBERTI AND PIZZURNO 2013, p. 143). R&D is primarily need-oriented with a limited amount of basic research and often short-term and intuitive R&D activities (PFOHL AND ARNOLD 2006, p. 21).

In addition, the utilisation of formalised instruments of planning and controlling of processes and projects is limited, as well as the according competences of employees. This **lack of methodical knowledge** results in often spontaneous, unsystematic and less target-oriented activities, which negatively affect the company's innovativeness (AHSEN et al. 2010, p. 4; MEYER 2013, p. 236; SPITHOVEN et al. 2013, p. 555). Along with a lack of resources for project failures, this cause the need of a systematic methodical support in developing and managing innovations (MEYER 2013, p. 220). This could also reduce another disadvantage of SMEs: particularly small SMEs face the challenge that they grew mainly due to one specific innovation. Its success hinders new innovations as the SMEs focus on this original innovation and neglect alternative R&D investments (GASSMANN AND SUTTER 2008, p. 4). Nevertheless, if they have too many innovation projects, they risk to obstruct their innovation pipeline due to missing capacities (GASSMANN AND SUTTER 2008, p. 5).

In general, SMEs have a less diversified **product portfolio** due to a high specialisation and focus on specific core competences, business fields and customer needs (ADERHOLD AND RICHTER 2006, p. 10; AHSEN et al. 2010, p. 4). The products and services are highly customer-oriented and the main sales argument is trust of customers into the entrepreneur and company (HAMER 2013, p. 35). Due to this less diversified product portfolio, AHSEN et al. (2010, p. 4) argue that SMEs can react fast to changing market conditions.

In this respect, SMEs often face an externally induced pressure for innovations from their **market environment**, such as improved or novel technologies, new products and services of competitors, changing customer needs and changed legal boundary conditions (MEYER 2013, p. 234). Due to their high flexibility, SMEs are able to quickly react to those changes. However, in contrast to MNEs and their strong lobbies, they normally cannot affect those changes but need to work with them (MEYER 2013, p. 235).

An important way to deal with these external challenges are collaborations with **external partners**. The entrepreneur is usually technically experienced and stands in direct contact to a close network of suppliers and customers (AHSEN et al. 2010, p. 4). Within their cooperation, trust is a central aspect (HAMER 2013, p. 35). In this regards, they seem to prefer customers (THEYEL 2013, p. 270) and show a low motivation to cooperate with consultants (MEYER 2013, p. 236). ALBERTI AND PIZZURNO (2013, p. 143) indicates a general aversion against external collaborations, which could be one reason, why SMEs tend to focus on already known external partners in the case of external collaborations (HYLL AND PIPPEL 2016, p. 463). However, in general, industry studies show that **SMEs, which cooperate with external partners, are more successful** (DLR 2013, p. 6). Therefore, it is important to develop approaches and methodologies to support SMEs in collaborating with external partners, in order to maintain and strengthen their innovation capabilities and market position.

2.4.4 Mittelstand enterprises and Open Innovation in literature

Open Innovation (OI) is a holistic innovation concept for collaborating with external partners (cf. chapter 2.3). Already in 2010, GASSMANN et al. (2010, p. 219) stated the need for a detailed consideration of supporting SMEs in applying OI. In terms of a general OI application in SMEs, a kind of need and ability chasm is reported by BARGE-GIL (2010, p. 582f) and VAN DE VRANDE et al. (2009, p. 435): the smaller a company the higher its need for OI but the lower its capabilities to apply it, while large companies can more easily apply OI but only have a low need. This is consistent with the empirical results of HENTTONEN AND RITALA (2013, p. 15). HOSSAIN (2015, p. 1) states that less than 20% of SMEs actively use OI. To enable SMEs to benefit from OI, the following sections analyse the current application of OI in SMEs, in order to understand the reasons for this low application. The subsequently derived success factors and barriers of OI in SMEs serve as basis for identifying central industry needs and resulting research gaps in the following chapter.

Application of Open Innovation in Mittelstand enterprises

To date, academia faces the challenge that literature and studies concerning OI in SMEs and family firms are limited. HOSSAIN (2013; 2015) and SALVADOR et al. (2013) provide overviews of relevant literature in OI. Different studies analyse specific aspects of OI in SMEs, such as VAN DE VRANDE et al. (2009) who analyse motives, barriers and success factors in a study with 605 Dutch SMEs, LEE et al. (2010) who analyse innovation management and opportunities for OI in 2414 SMEs and 329 MNEs in South Korea, VEGA et al. (2012) who address on university-based public programs, HENRY AND WYNARCZYK (2013) who focus on OI in SMEs in the UK, SPITHOVEN et al. (2013) who analysed differences in OI in a study with Belgian SMEs and MNEs, and LAZZAROTTI AND PELLEGRINI (2015) who focus on innovation characteristics of family firms that are managed by family and non-family members. The industry study of DLR (2013) focusses on cooperation in German SMEs. Other authors focus on a literature-based analysis of SME-specific barriers of OI, such as SALVADOR et al. (2013, p. 359), VERBANO et al. (2015, p. 1059) and VAN DE VRANDE et al. (2009, p. 425).

When applying OI, SMEs tend to focus on traditional partner types, such as suppliers and customers, and avoid new partners, for instance, competitors (ALBERTI et al. 2014, p. 38). Non-monetary forms of OI are favoured, such as networking and informal knowledge sourcing (BRUNSWICKER AND VANHAVERBEKE 2015, p. 1243). Type of collaboration and partners depend on the specific purpose (HOSSAIN 2015, p. 5). Nevertheless, cooperation in later innovation phases are most common, for instance, for prototype design and testing (CARVALHO AND MOREIRA 2015, p. 13). The application of OI is usually need-dependent and cost-triggered on a case-by-case basis but lacks a long-term utilisation. However, if SMEs establish relationships to external partners, these are usually long-term constructs (CARVALHO AND MOREIRA 2015, p. 13). According to the results of an empirical study of BRINK (2014, p. 21), coupled OI in particular has a positive effect on the economic performance of SMEs, although SMEs seem to be less effective to develop new products and services with OI than MNEs (SPITHOVEN et al. 2013, p. 556). SMEs apply OI more intensively than MNEs but face a higher risk of getting dependent from OI and external knowledge: R&D-based needs are often solved by external knowledge in the short-term, but own internal long-termed capabilities are not established, which results in a continuous need of external knowledge and capabilities (SPITHOVEN et al. 2013, p. 555).

In summary, although OI has been applied in SMEs and studies have started to analyse it, both are still very limited to date. In addition, there is the shortcoming of some publications to use the terms SME and OI but do not discuss the specific characteristics of OI in SMEs in comparison to MNEs. Often only a positive effect of OI is stated but OI itself is only one analysed influencing factor on innovation management among various others, see for instance KUMAR et al. (2012) and VEGA et al. (2012). A holistic overview and consideration of OI in SMEs is still missing. Therefore, the following section identifies motives of SMEs for applying OI and analyses success factors and barriers. This serves as basis for a subsequent analysis of industry needs and research gaps (chapter 3) as well as for the requirement analysis of according methodical support (chapter 4).

Reasons for Open Innovation in Mittelstand enterprises

This section focusses on reasons why OI is especially beneficial for SMEs. HOSSAIN (2015, p. 9) and LEE et al. (2010, p. 291f) see particularly benefits of OI in the commercialisation phase rather than in R&D. Nevertheless, this would fall to short and miss a majority of benefits of OI: it supports in staying competitive by better meeting customer demands (HOSSAIN 2015, p. 9) due to a better market understanding (ALBERTI AND PIZZURNO 2013, p. 154). This means that this market-related knowledge of needs as well as solution-specific knowledge has to be utilised all over the innovation process. External knowledge exchange is important for a better business performance and faster innovation processes, particularly for SMEs (ALBERTI AND PIZZURNO 2013, p. 155; CHRISTENSEN et al. 2005, p. 1545; RAHMAN AND RAMOS 2011, p. 48). SMEs need OI to better assess external knowledge and capacities to compensate external innovation and competition pressure (cf. MEYER 2013, p. 234), to handle the continuously increasing complexity of technologies that are no longer manageable by a single company, and to manage the increasing global distribution of relevant knowledge and partners (LEE et al. 2010, p. 291).

In respect to the latter aspect, OI also supports in increasing the **public awareness of a SME** and attracting new potential employees (LINDERMANN et al. 2009, p. 36f). This can compensate the often decentral location of SMEs remote from larger cities (cf. SIMON 2013, p. 60). In general, OI can help to solve the challenge of only **limited R&D personal** (MEYER 2005,

p. 292) and limited access to knowledge and experts (VAN DE VRANDE et al. 2009, p. 426). While the company's knowledge base can be broadened by expertise from various fields (CARVALHO AND MOREIRA 2015, p. 13), university cooperation allows an early access to new technologies and potential future recruits (VANHAVERBEKE et al. 2008, p. 256). The **problem-solving capabilities** of universities can enhance the limited internal capabilities and resources (PERKMANN et al. 2011, p. 205), extend the own application driven research by results of **basic research** (PFOHL AND ARNOLD 2006, p. 21) and allow an early participation in new business opportunities, such as university spin-offs and start-ups (VANHAVERBEKE et al. 2008, p. 256).

Along with personnel aspects, OI can compensate the **limitation of internal resources** (HENRY AND WYNARCZYK 2013, p. 262; MEYER 2005, p. 292; VAN DE VRANDE et al. 2009, p. 426) and the resulting lack of covering all relevant innovation activities within the company (BRUNSWICKER AND VANHAVERBEKE 2015, p. 1243). OI allows the access to and sharing of technological and R&D capabilities and resources of other companies (ASCHEHOUG AND RINGEN 2013, p. 3; BRINK 2014, p. 20; BRUNSWICKER AND VANHAVERBEKE 2015, p. 1243; LINDERMANN et al. 2009, p. 35) and access to venture capital (VANHAVERBEKE et al. 2008, p. 256). Another important aspect is **sharing R&D risks** within external cooperation (CARVALHO AND MOREIRA 2015, p. 13).

OI supports the growth of SMEs in terms of innovation and economic performance (BRINK 2014, p. 20; SPITHOVEN et al. 2013, p. 556; VAN DE VRANDE et al. 2009, p. 432) and reduce the negative effects of the **company's smallness**, which limits their organisational space of action (HENRY AND WYNARCZYK 2013, p. 262). OI also allows organisational learning (BRINK 2014, p. 20; SALVADOR et al. 2013, p. 366) and solve the lack of managerial skills (AHSEN et al. 2010, p. 4; TEIRLINCK AND SPITHOVEN 2013, p. 142). External R&D collaborations enable the **utilisation of external expertise** and **enhancement of internal R&D capacities** and core competences (LEE et al. 2010, p. 298; SALVADOR et al. 2013, p. 366; TEIRLINCK AND SPITHOVEN 2013, p. 142). OI increases the, often limited, **understanding of customers** (VAN DE VRANDE et al. 2009, p. 432) and other relevant stakeholders (VAQUERO MARTÍN et al. 2015, p. 1).

Success factors of Open Innovation in Mittelstand enterprises

In general, due to their previously described characteristics (chapter 2.4.3), SMEs need another organisation of their product development processes than MNEs to be able to sufficiently use human and financial resources and prevent conflicts between daily business and innovation activities (MASSIS et al. 2016, p. 19). HENRY AND WYNARCZYK (2013, p. 273), in line with MASSIS et al. (2016, p. 19), state two central success factors for OI in SMEs: (1) their ownership and management structure that ensures political support of innovation activities (cf. MEYER 2013, p. 236), and (2) their internal R&D capacity and intensity that allow the utilisation of external knowledge in terms of ***absorptive capacity***[17] (COHEN AND LEVINTHAL 1990). However,

[17] The term ***absorptive capacity*** summarises all abilities of individuals and a company to identify, value, assimilate and operationalise external knowledge within the company's innovation process, for instance, as number R&D personal (ALBERTI et al. 2014, p. 43; SPITHOVEN et al. 2013, p. 556; TEIRLINCK AND SPITHOVEN 2013, p. 152; HUANG AND RICE 2009, p. 212).

investments in absorptive capacity are no short-term measures since they show their effects in the medium to long run (HUANG AND RICE 2009, p. 213).

Another main success factor of OI in SMEs is their **innovation strategy**, which provides direction and coordination to all innovation activities, and supports in identifying and assessing external knowledge (BRUNSWICKER AND VANHAVERBEKE 2015, p. 1245; CARVALHO AND MOREIRA 2015, p. 13). LAZZAROTTI AND PELLEGRINI (2015, p. 193) found that a more aggressive innovation strategy results in a higher degree of openness.

A sufficient **innovation and project management** enables the coordination of collaborations and operationalisation of external knowledge (SCHWAB et al. 2011, p. 5; TEIRLINCK AND SPITHOVEN 2013, p. 152). It also supports in adapting to changing environmental boundary conditions (RAHMAN AND RAMOS 2013, p. 436). In this regards, **long-term innovation investments** provide reliable allocation of resources and allow additional investments in experimental and risky R&D projects. These enable radical innovations in the long-run but do not show benefits in the short-run (BRUNSWICKER AND VANHAVERBEKE 2015, p. 1245). In addition, a **defined product development process** coordinates innovation activities in a systematic way and is requirement for assimilating and utilising external knowledge (BRUNSWICKER AND VANHAVERBEKE 2015, p. 1246; CARVALHO AND MOREIRA 2015, p. 13; DLR 2013, p. 32). A sufficient **innovation project control** is necessary to define innovation goals, and control the project's progress and compliance of schedules and costs (BRUNSWICKER AND VANHAVERBEKE 2015, p. 1246; DLR 2013, p. 32). This is directly linked to an appropriate planning of the goal of OI and the OI project (DLR 2013, p. 32).

OI also requires an open-minded **company culture** and willingness for knowledge exchange (VERBANO et al. 2015, p. 1055), including the awareness of the own culture and business model (BRAUN 2015, p. 71). From a collaborative perspective, the culture, value systems and business models of SMEs and their OI partners need to match (BRINK 2014, p. 20), and reciprocity between all actors need to be established (BRAUN 2015, p. 70). **Networking** is an effective way to build on known external partners, involve new ones and enable OI (LEE et al. 2010, p. 291).

Another important factor is the setup of the **design and OI team**, that organises an OI project. Its members should come from different departments to combine various competences and skills (MASSIS et al. 2016, p. 13; RAHMAN AND RAMOS 2013, p. 436). Members of the entrepreneur's family can have a coordinating function across boundaries of departments. Team members should be assigned to the project depending on specific needs and not permanently (cf. also ALBERS et al. 2005, p. 7). In respect to the team leadership, non-family managers tend to have a more aggressive innovation strategy, which results in a higher degree of openness and more radical innovations than family managers (DLR 2013, p. 32; LAZZAROTTI AND PELLEGRINI 2015, p. 196). In general, the existence of a **research and innovation manager** has a positive effect on OI activities, particularly for cooperation with universities and research institutes (TEIRLINCK AND SPITHOVEN 2013, p. 151). In general, a specific person is required, who is contact person and responsible for the OI project (DLR 2013, p. 32).

In respect to internal barriers, it is important to **motivate employees** in an appropriate way. Intrinsic incentives usually show a higher effectiveness than extrinsic and monetary ones (MASSIS et al. 2016, p. 18). Incentives should address the common identity of employees and link team members with successful project results in the employees' awareness. In this regards, mutual **trust** and respect between employees as well as employees and company is a crucial factor (Aschehoug and Ringen 2013, p. 9; DLR 2013, p. 33). In terms of motivation on a company level, management support is crucial for OI as it affects the motivation of relevant employees as well as the allocation of space from daily business and necessary resources for the OI project (DLR 2013, p. 33; Giannopoulou et al. 2011, p. 508f; van de Vrande et al. 2009, p. 433).

Similar to the previously mentioned absorptive capacity, SMEs need **dynamic capabilities**. The flexible and pragmatic character of SMEs and low level of bureaucracy allow adaptations to changing boundary conditions and application of new management concepts (Aschehoug and Ringen 2013, p. 10; Rahman and Ramos 2010, p. 479; Salvador et al. 2013, p. 366; Schwab et al. 2011, p. 5). It also supports in absorbing market-based knowledge and applied technologies (Spithoven et al. 2013, p. 556).

SMEs need an appropriate learning period and establishment of OI-specific managerial competences (Salvador et al. 2013, p. 366). SMEs also have to be familiar with and use modern communication channels like social media (Schwab et al. 2011, p. 6). Due to their limited resources and their dependence on the sale of innovative products, SMEs need sufficient intellectual property (IP) protection strategies and mechanisms (Spithoven et al. 2013, p. 556).

Along with the previous factors, the most essential success factors for OI is the establishment of a **trustful relationship** and appropriate **communication** between the company and OI partners (Colombo et al. 2011, p. 179, DLR 2013, p. 33; 2013, p. 27; Giannopoulou et al. 2011, p. 514; Hu et al. 2015, p. 593f; Paasi et al. 2010, p. 634; Solesvik and Gulbrandsen 2013, p. 15). It affects the quality and quantity of knowledge exchanges as well as the behaviour of OI partners, for instance, in terms of handling IP[18].

Barriers of Open Innovation in Mittelstand enterprises

The following section discusses typical barriers of OI in more detail. **Limited workforce and financial resources** are major barriers for SMEs since costs and effort for establishing and maintaining external partnerships as well as new organisational structures are high (Alberti et al. 2014, p. 43; DLR 2013, p. 31; Rahman and Ramos 2010, p. 479; Schwab et al. 2011, p. 6; Spithoven et al. 2013, p. 555; Teirlinck and Spithoven 2013, p. 145; Verbano et al. 2015, p. 1059). In addition, van de Vrande et al. (2009, p. 425) also state the effort of executing an OI project and operationalising its results. In general, insufficient resources also limit planning horizons to a short and medium range (Rahman and Ramos 2010, p. 479). Many SMEs also do not have capacities for a systematic R&D (Hossain 2013, p. 34). Along with a general lack of personal, the lack of specifically qualified personal is stated (Huang and Rice 2009, p. 212; Rahman and Ramos 2010, p. 479; 2013, p. 440). In addition, SMEs often do not have access to external finances to compensate internal lacks (Huang and Rice 2009, p. 212; Rahman and Ramos 2013, p. 440). The "*liability of smallness*" (Aschehoug and Ringen 2013, p. 10; Gassmann et al. 2010, p. 216) can cause further barriers, for instance, the lack of necessary infrastructure for OI (Rahman and Ramos 2010, p. 480; 2013, p. 440).

[18] For the importance of trust in OI collaborations also see chapter 6.3.

VAN DE VRANDE et al. (2009, p. 425) also empirically identified **administrative obstacles**, such as bureaucracy and conflicting rules as well as missing commitment of managers and employees (also: RAHMAN AND RAMOS 2010, p. 480). **Organisational deficits** can result in a poor balance of daily business and OI (SCHWAB et al. 2011, p. 6), as well as focussing only on short-term market needs (RAHMAN AND RAMOS 2010, p. 479). Along with **insufficient project management** (VERBANO et al. 2015, p. 1059), other barriers are **a lack of experience and competences** of managers and employees in planning OI projects, defining realistic goals and operationalising the project results, which often comes along with incorrect expectations towards OI (DLR 2013, p. 31; also: RAHMAN AND RAMOS 2013, p. 442; VERBANO et al. 2015, p. 1059). Particularly missing experience of identifying and selecting OI partners is a great challenge (VERBANO et al. 2015, p. 1059). In this respect, SMEs have a lower search breadth than MNEs and tend to focus on known partners (ALBERTI et al. 2014, p. 38). SMEs often lack **marketing competences**, which complicates to overcome limitations of public awareness and to attract external partners for a collaboration (LINDERMANN et al. 2009, p. 34; VAN DE VRANDE et al. 2009, p. 425).

VERBANO et al. (2015, p. 1059) also state, **opportunistic behaviour** of external partners, **cultural resistance** inside the company and **cultural differences** between company and external partners. The latter can be exacerbated by **lacking knowledge about potential OI partners** (LINDERMANN et al. 2009, p. 36) and by a **missing understanding** of the business model and project role of the partner (BRAUN 2015, p. 70). Along with difficulties of **protecting own IP** (RAHMAN AND RAMOS 2013, p. 440), **insufficient motivation and incentives** for internal stakeholders represent a serious barrier. This is often linked to the **fear** of getting dependent of external partners (SPITHOVEN et al. 2013, p. 555), and a general **risk aversion** of entrepreneur and managers (RAHMAN AND RAMOS 2010, p. 480; SCHWAB et al. 2011, p. 5).

Other challenges of applying OI are a **lack of market knowledge** (LINDERMANN et al. 2009, p. 33; RAHMAN AND RAMOS 2013, p. 440), a lack of technical expertise (RAHMAN AND RAMOS 2010, p. 480), missing networks (HUANG AND RICE 2009, p. 212; RAHMAN AND RAMOS 2010, p. 479), governmental regulations (RAHMAN AND RAMOS 2013, p. 440) and sometimes an "*organisational rigidity*" that hinders dynamic adaptions to changing boundary conditions (RAHMAN AND RAMOS 2013, p. 436f).

2.5 Evaluative summary of the state of the art

Product development, as part of product engineering, represents the **central element of an innovation process**. It creates the inventions that are subsequently transformed into innovations by successful commercialisations and diffusions. To achieve innovations, it is necessary to organise the innovation activities and their sequence as innovation processes, including an appropriate innovation management and controlling. In this respect, **projects** are an organisational form, which is also particularly **relevant in the context of Open Innovation** (OI). Projects are characterised by their separation from other organisational structures and a resulting encapsulation. They comprise a specific goal, a start and an end date as well as a defined team and resources.

Since technical systems and according processes become increasingly complex in the context of a socio-technical system, appropriate **methodical support is crucial**. It helps unexperienced users, for instance product developers, with a systematic operative guideline, but also experienced users are supported in unfamiliar situations or in terms of reflecting and improving entrenched habits. Depending on the level of abstraction, this support can range from single methods up to holistic methodologies and product engineering models.

Due to the increasing complexity of products and their surrounding **socio-technical system**, innovations are usually the result of a cooperative process. A relatively novel innovation concept is **Open Innovation** (OI), which explicitly focusses on external cooperation. OI represents a holistic innovation framework. It directly links to established approaches, such as systems engineering and integrated product engineering, but also enhances them by new types of partners and forms of collaborations. Along with traditional dyadic collaborations, OI enables the collaboration with large crowds and globally distributed groups of partners. These partners also play a more active role within the innovation projects: they no longer only provide knowledge of needs and passively consume the resulting products. Now, they are also actively involved in OI projects as solution providers.

To date, **OI is mainly applied in large multinational enterprises** (MNEs). Nevertheless, as several authors state, OI bears great benefits and relevance in particular for SMEs (BARGE-GIL 2010, p. 597; HOSSAIN 2015, p. 1; VAN DE VRANDE et al. 2009, p. 434). These are particularly relevant for the economy of a nation. Although there are differing definitions, they all show a high level of similarities compared to MNEs. Within this dissertation, SME and Mittelstand enterprise are considered synonyms and are characterised by the following properties:

1. **maximum of 2,500 employees**
2. **maximum of 500 million Euro** annual turnover
3. **management by an entrepreneur** and/or his family.

The application of OI in SMEs is limited. The analysis of underlying reasons identified success factors and barriers of OI in SMEs were identified. In particular, barriers are of high relevance as they indicate potential industry needs and research gaps for the following chapter.

3. Detailed analysis of research gaps of Open Innovation in SMEs

As described before, OI provides various benefits for SMEs, but also bears risks as well as SME-specific barriers and challenges. These are indicators for potential industry needs. Based on them and a further literature review, this chapter analyses OI-specific industry needs in more detail. The findings are evaluated by a subsequent two-step empirical evaluation in cooperation with industry partners. The results are consolidated to nine main research gaps concerning OI in SMEs. From them three primary gaps are selected, which are focused on in this dissertation, along with three secondary gaps.

3.1 Needs concerning Open Innovation in literature

The barriers of OI in SMEs, which are identified in the previous chapter, indicate potential industry needs concerning OI in general and methodical support for enabling OI in SMEs in particular. These potential industry needs were enhanced by a literature review focussing on these needs. This literature comprises conceptual publication, quantitative studies and case studies. By analysing them in detail, the following areas of needs were derived.

Reduction of risks

A central challenge of applying OI is the occurrence and **management of risks and barriers**, which hinder the success of an OI project. A main risk of OI and need of SMEs is an appropriate **protection of intellectual property (IP)** (ENKEL et al. 2009b, p. 314; GASSMANN et al. 2010, p. 219; HOSSAIN 2013, p. 36; 2015, p. 9; HUIZINGH 2011, p. 6). SPITHOVEN et al. (2013, p. 556) argue that SMEs primarily profit by selling products and services, while SIMON (2013, p. 60) state a particularly strong competition between SMEs, in order stress the relevance of IP protection. To protect IP and ensure the utilisation by the own company, a careful balancing between publishing internal knowledge for enabling an OI collaboration, and protecting knowledge for avoiding knowledge drain is essential (GIANNOPOULOU et al. 2011, p. 509f). HENKEL (2006) calls it ***"selective revealing"*** of knowledge. Along with the threat of product imitations by competitors (LEE et al. 2010, p. 296), there is also the challenge **how to handle knowledge and IP** that was developed in cooperation with external partners within the OI project (*IP hygiene*): companies tend to claim exclusive exploitation rights instead of involving the respective OI partners in the economic success of the resulting product. Failures in this respect can damage the reputation of the company, and reduce the motivation and loyalty of OI partners (GASSMANN 2013, p. 18f).

Improved applicability and implementation of Open Innovation

Along with reducing risks and barriers, several authors state the need of an improved applicability and usability of OI, including the questions of **how to organise OI** (GIANNOPOULOU et al. 2011, p. 505; HUIZINGH 2011, p. 5; WEST et al. 2014, p. 807) and **how to implement OI in the long-run** (GIANNOPOULOU et al. 2011, p. 519f). To date, a **holistic**

implementation strategy for embedding OI within the company and establishing partnerships does not exist (CHESBROUGH AND BRUNSWICKER 2013, p. 29; HUIZINGH 2011, p. 5). This is additionally exacerbated by the general **pressure to quickly generate revenue** from innovation (MEYER 2013, p. 240), which leads to a prioritisation of the routine business and a lack of space for innovation activities, in particular for OI (ILI AND ALBERS 2010, p. 56; MEYER 2013, p. 236). It can also cause the risk that tediously gained external knowledge is not operationalised within the innovation process (GASSMANN 2013, p. 18). Therefore, SMEs need to **overcome organisational and cultural barriers** to operationalise the knowledge from an OI project (VAN DE VRANDE et al. 2009, p. 434). In addition, the establishment of external partnerships is essential but expensive, and is most beneficial only in the context of a long-term implementation (cf. HUIZINGH 2011, p. 5). Therefore, SALVADOR et al. (2013, p. 356) identify the need for systematic implementation strategies, methodologies and tools.

Systematic application of Open Innovation

A central element of an improved applicability of OI is a **systematic application process**. As MEYER (2005, p. 292) states, SMEs have a general need for a professional innovation management to develop innovative ideas, transform them into innovations and systematically manage these innovations. Innovation activities of SMEs are often only short-termed and intuitive rather than systematic, due to organisational and individual deficits (MEYER 2013, p. 236; PFOHL AND ARNOLD 2006, p. 21). Thus, SMEs need the knowledge and application of different methods supporting innovation management (MAURER AND VALKENBURG 2011, p. 78; MEYER 2005, p. 292) but face the challenge of a merely limited application of methods in companies (GERICKE et al. 2013, p. 2).

To date, companies apply OI in a **trial-and-error approach** instead of a systematic process (CHESBROUGH AND BRUNSWICKER 2013, p. 24; GASSMANN et al. 2010, p. 216; HUIZINGH 2011, p. 6; MAURER AND VALKENBURG 2012, p. 247). However, **SMEs cannot afford failures of OI projects** due to their limited resources (ADERHOLD AND RICHTER 2006, p. 11; AHSEN et al. 2010, p. 4; PFOHL AND ARNOLD 2006, p. 18). In addition, a once failed new approach will not be applied a second time ("*scorched earth*" effect). Therefore, the initial OI project has to be an immediate success. However, in line with GERICKE et al. (2013, p. 2), SMEs lack the necessary methods, processes, systems and culture for using OI (CHESBROUGH AND BRUNSWICKER 2013, p. 37; ILI AND ALBERS 2010, p. 56). This is a major challenge since open processes are more complex than closed ones due to new and more activities, and a higher coordination effort (VAN DE VRANDE et al. 2009, p. 425).

An integrated methodology is missing, which helps managers to decide, when, where and how to apply OI, in particular in which innovation phase and with what OI partners (DAHLANDER AND GANN 2010, p. 707; GIANNOPOULOU et al. 2011, p. 518; HUIZINGH 2011, p. 6). Both aspects in accordance to BOGERS AND WEST (2012, p. 67) and their three "*core challenges*" of how to systematically (1) identify external sources of knowledge, (2) ensure this knowledge supply, and (3) commercialise the resulting inventions. To ensure an industrial applicability of such a planning methodology, it is essential that it comprises methods that fulfil the specific requirements of SMEs (SALVADOR et al. 2013, p. 367).

Search for external knowledge and partners

The success of an OI project depends on the access to external knowledge sources and assessment of their specific relevance to the OI project (SALGE et al. 2012, p. 5). In particular, the **utilisation of different and heterogeneous knowledge sources** has a positive effect on the innovation performance and resulting competitive advantages (HENTTONEN AND RITALA 2013, p. 14; PARIDA AND JOHANSSON 2009, p. 445). Therefore, the search for OI partners is an essential success factors for establishing successful **partnerships** (HU et al. 2015, p. 585; LI et al. 2008, p. 315; SOLESVIK AND GULBRANDSEN 2013, p. 11).

Despite its relevance, the **search for OI partners** is a main challenge for companies and associated with uncertainties (GIANNOPOULOU et al. 2011, p. 505; LEE et al. 2010, p. 296; LOPEZ-VEGA et al. 2016, p. 125; MAURER AND VALKENBURG 2011, p. 77; 2012, p. 247), as not all knowledge elements and OI partners are equally suitable and relevant for a specific OI goal (BRUNSWICKER AND VANHAVERBEKE 2015, p. 1243). The **choice of wrong OI partners** is linked to various risks of OI, such as collaboration difficulties, low project performance and cost-benefit ratio, focussing on irrelevant market needs and knowledge drain (BROCKHOFF 1997; ENKEL 2009, p. 177; HYLL AND PIPPEL 2016, p. 463; KIRSCHNER 2012, p. 44; MANOTUNGVORAPUN AND GERDSRI 2015, p. 718f). In this respect, an important barrier for SMEs is the difficulty to find suitable OI partners and knowledge (BOGERS AND WEST 2012, p. 67; ENKEL 2009, p. 190; HILGERS AND PILLER 2009, p. 6; PARIDA AND JOHANSSON 2009, p. 440), due to complex external networks with heterogeneous actors, and dynamic interactions and relationships on multiple levels (COLOMBO et al. 2011, p. 190; NONAKA 2014, p. vii). Along with **increased organisational complexity and costs**, a **lacking search focus** is a particular challenge for SMEs (HENTTONEN AND RITALA 2013, p. 15). SMEs are overwhelmed by the search for and management of OI partners (HOSSAIN 2015, p. 3; VAN DE VRANDE et al. 2009, p. 433). The effort of partner search and fear of knowledge drain often result in "***lock-in effects***" when companies focus on their close environment and known partners, and neglect potential alternative OI partners (HYLL AND PIPPEL 2016, p. 463; ILI AND ALBERS 2010, p. 56; MAURER AND VALKENBURG 2012, p. 243; SOLESVIK AND GULBRANDSEN 2013, p. 12f).

Therefore, it is **necessary to identify the right set of OI partners** for solving a problem as well as to consider all relevant stakeholders to ensure the success of a product (BJØRKQUIST et al. 2015, p. 10; GIANNOPOULOU et al. 2011, p. 510; HUIZINGH 2011, p. 5; KARLSEN 2002, p. 19; SOLESVIK AND GULBRANDSEN 2013, p. 11; VAQUERO MARTÍN et al. 2015, p. 1). Along with customers as *usual suspects*, there is a multitude of other stakeholders (VAQUERO MARTÍN et al. 2015, p. 1). The type of OI partners and collaborations depends on the specific goal of the OI project (HOSSAIN 2015, p. 5). For instance, the search for cross-industry partners is particularly challenging and requires appropriate processes and methods (BRUNSWICKER AND HUTSCHEK 2010, p. 683; ENKEL AND GASSMANN 2010, p. 257; ILI AND ALBERS 2010, p. 56).

In summary, there is the need of a **methodical support for companies in identifying OI partners** and **objectively assess their OI project relevance** (cf. MANOTUNGVORAPUN AND GERDSRI 2015, p. 719). In particular SMEs do not adopt systematic search strategies (HOSSAIN 2015, p. 9). In addition, academia tends to focus on the question ***where*** to search in terms of search spaces but neglects the aspect of ***how*** to search. Nevertheless, it is important to combine both aspects (LOPEZ-VEGA et al. 2016, p. 125). Along with this, the OI partner search usually focus on a company level, although OI is a "*project-based, interfirm cooperation*" (MANOTUNGVORAPUN AND GERDSRI 2015, p. 718f). It is also necessary to analyse in more detail, how OI can be applied within networks (WEST et al. 2014, p. 809) and how to ensure trust as a success factor of collaborations with OI partners (HOSSAIN 2015, p. 9; MAURER AND VALKENBURG 2011, p. 77).

Selection of suitable collaboration methods

Along with the identification of suitable external knowledge, it is essential to access and utilise it in an appropriate way. A common shortcoming is using a way of collaboration, which does not support the specific characteristics and needs of the particular OI partners and the company. Therefore, HUIZINGH (2011, p. 5) states the need of **systematically selecting suitable OI methods**. In particular for SMEs, the selection of OI methods is a major challenge (BERGMANN et al. 2009, p. 152; GIANNOPOULOU et al. 2011, p. 513; HOSSAIN 2015, p. 3). In general, the selection of appropriate methods is essential, as each one was developed for a specific purpose (cf. LINDEMANN 2009, p. 57), and requires systematic support (ALBERS et al. 2015a, p. 2). Another important aspect in the context of OI methods is the selection and **formulation of an appropriate task description** that shall be solved by using the OI method (HUIZINGH 2011, p. 5; LOPEZ-VEGA et al. 2016, p. 131).

Context-specific planning and application of Open Innovation

The previous needs get exacerbated by the fact that OI cannot be applied uniformly but **has to be adapted to the specific context**, which influences the execution and success of the OI project (DITTRICH AND DUYSTERS 2007, p. 512; GIANIODIS et al. 2010, p. 559; HUIZINGH 2011, p. 4; SOLESVIK AND GULBRANDSEN 2013, p. 15). Exemplary influencing factors on OI are the addressed technology and industry sector (DAHLANDER AND GANN 2010, p. 707), the company's organisation structure, size and culture (LOREN 2011, p. 14), and the goal and partners of the OI project (HOSSAIN 2015, p. 5). However, the context and influencing factors of OI are not completely understood so far (ENKEL et al. 2009b, p. 312; HOSSAIN 2013, p. 35).

Involvement and motivation of internal stakeholders

Along with a sufficient involvement of external OI partners, a sufficient involvement and motivation of **employees, or internal stakeholders in general**, is essential for the success of OI projects (GIANNOPOULOU et al. 2011, p. 508f; ILI et al. 2010, p. 252f). In terms of the **Not-Invented-Here (NIH) syndrome** (GROSSE KATHOEFER AND LEKER 2012; KATZ AND ALLEN 1982), in particular SMEs face the barrier of employees rejecting changes and renewals (MEYER 2013, p. 239). Employees in SMEs consider themselves a team and see the appreciation of their work as a basic motivation factor (HAMER 2013, p. 33f). There is the risk that they see OI as a potential substitution of their jobs and a missing appreciation of their work. Therefore, they need to be appropriately convinced and motivated for OI (GIANNOPOULOU et al. 2011, p. 519).

Performance measurement and controlling of Open Innovation

In the previous respect, an effective measurement of the OI success and performance is essential (WEST et al. 2014, p. 807) as it supports in motivating actors along with supporting innovation activities and decisions, and improve processes (CHIESA et al. 2008, p. 213; ENKEL et al. 2011, p. 1162). A profound proving of the benefit of OI is essential for the **acceptance of OI by internal stakeholders** (GASSMANN 2013, p. 189). In addition, GASSMANN (2013, p. 18) states the relevance of **assessing the costs and benefits of OI**, as a common problem is an underestimation of total costs, which also comprises costs for preparations, evaluation of results and their operationalisation, along with costs of the execution of the OI project.

However, OI brings new needs concerning **innovation controlling** (HILGERS et al. 2011, p. 84). A holistic assessment methodology for OI does not exist, which combines an external and internal perspective, including sufficient performance metrics (BLOHM et al. 2011, p. 102; CHESBROUGH AND BRUNSWICKER 2013, p. 30; ENKEL et al. 2011, p. 1162). Already traditional innovation controlling is challenging, since the measurement of positive and negative effects is difficult due to complex and dynamic interdependencies between the effects (BRANDT 2004, p. 33f; ENKEL et al. 2011, p. 1162; LOCH AND TAPPER 2002, p. 186). Other challenges are differing perspectives concerning the success and failure, temporal delays and differing locations of effort and results of an innovation, for instance, when the success is assigned to another department (ENKEL et al. 2011, p. 1162; LOCH AND TAPPER 2002, p. 186).

A central challenge is the definition of reasonable metrics and reference scales for a comparison of actual and target state (ENKEL et al. 2009b, p. 314; 2009b, p. 314; GASSMANN AND SUTTER 2008, p. 18; HILGERS AND PILLER 2009, p. 8). This is important to motivate employees and give them a goal and a vision. Solely monetary measurement parameters are not sufficient, but non-monetary parameters are necessary as well in terms of a multi-perspective performance measurement system (LOCH AND TAPPER 2002, p. 186; PERKMANN et al. 2011, p. 206).

3.2 Empirical study of Open Innovation needs in SMEs

Based on the needs previously identified in literature, a qualitative study in industry was conducted. Its goal was to evaluate if OI concepts from academia were efficiently and sustainably transferred and applied in industry, i.e. ***how is OI applied by companies***, ***which aspects works well*** and ***which ones need further improvements***. In addition, the study analysed expectations towards OI as well as concerns against OI. The study focussed on SMEs with B2B customers since OI is mainly studied and applied in large-scale enterprises. The study design contained two parts: in the first step, 13 German large-scale enterprises were interviewed to analyse the current application of OI in industry. Based on positive and negative experience with OI, challenges of OI and industry needs were derived. In the second step, the identified needs were evaluated in a workshop with 10 representatives of German SME to identify open research gaps. This chapter summarizes the central aspects and results of the empirical study. Detailed results of the study are presented in GUERTLER (2013) and GUERTLER et al. (2014b).

3.2.1 Study design

The initial **retrospective study** included 13 German large-scale companies from different industries (list of participants: see appendix 13.3.1). Since OI is already widely applied in large-scale companies (BRAUN 2012, p. 3), this allowed a broad overview of the industrial application of OI (GUERTLER 2013). The study also comprised companies without specific experience of

OI to identify concerns against an application of OI. However, all companies had experience with external collaborations. Based on this, challenges and barriers of OI, and potential research gaps were identified. The study also interviewed an OI intermediary. Its experience from various OI projects allowed an initial evaluation of findings within the study. Due to their geographical distribution, the interviews were conducted via telephone. A semi-structured questionnaire allowed to inquire interesting aspects in more detail (cf. appendix 13.3.3). It was sent to the companies beforehand. On request of the interview partners, the interviews were not recorded on tape but only notional. Subsequently, the responses were anonymised and analysed.

The goal of the subsequent **SME workshop** (GUERTLER et al. 2014b) was the evaluation of identified demands and research gaps of the retrospective study from an SME perspective. The participants were eight German SMEs from metalworking and electrical industries (list of participants: see appendix 13.3.2). The central questions of the two hours moderated workshop were: *What expectations towards outside-in Open Innovation do exist? What concerns and reservations against outside-in Open Innovation do exist?*

3.2.2 Results of the retrospective interview study

In the following, expectations and concerns regarding OI as well as positive and negative experiences with OI are presented.

Expectations towards Open Innovation

The interview study revealed three main motives of companies to apply OI. Especially for large companies with different business units and locations, it was important to (1) **improve their knowledge of their customers and markets**. Some companies had heard about OI and wanted to (2) **conduct an own test-run of this new innovation concept**. Another motive was using OI to purposefully (3) **improving the company's image (PR)** as "*young and innovative*". In this case, the regarding companies focussed more on attracting potential job applicants than on solving a technical problem.

Concerns against Open Innovation

Besides positive expectations towards OI, the study also revealed three central concerns. Based on the perceived high knowledge advance of the company, the (1) **benefit of involving external knowledge was rated as low** (cf. NIH syndrome). Opening the company's innovation process was also (2) **considered as potential risk of uncontrolled knowledge drain**. This could include concerns against publishing internal knowledge and against using external web-platforms in countries with access possibilities for third parties. In some cases, respondents could not state specific reasons for their concerns but only called it a vague (3) **"*gut feeling*"**.

Positive experience of applying Open Innovation

The reported positive experiences with OI largely match the stated previous expectations of the companies. The main benefit of OI was (1) **access to external sources of knowledge and expertise**. Even if not all of the gained OI input was directly applicable, it provided at least valuable inspiration for internal ideas. An (2) **increased understanding of customers** concerning their application of the product and their needs was stated as another major benefit. The gained knowledge could be used to improve the regarding products as well as related services. In line with stated expectations, an (3) **improved PR** was a relevant benefit besides technical aspects. By applying OI, the companies were perceived as “**young and innovative**” by customers and potential recruits. Particularly hidden champions stated the advantage of this PR improvement. In addition, companies mentioned (4) **new contacts and networks** with universities, individual experts, and partners in foreign markets as great benefit.

Challenges of applying Open Innovation

Besides positive experiences, the interviewed companies also reported the following challenges of applying OI and possible strategies for addressing them. (1) **General scepsis against OI** can be addressed by a clear communication strategy that stresses the benefits of OI as enhancement of internal innovation capabilities. This also supports to prevent the (2) **refusal of external input** due to regarding it as less in value or as thread (cf. NIH, chapter 2.3.4). Closely linked are (3) **concerns against cost-benefit ratio**. Since a reported insufficient cost-benefit ratio was often based on inadequately planning the OI project, the **planning was identified as important success factors for OI**. (4) **Insufficient transfer of OI input into the product development process** is often based on an inadequate operationalisation. OI input needs to be structured and processed in a way that internal departments can comprehend and use it. (5) **Embedding of OI in the company** was reported as challenging due to the need of designing new process interfaces and organisational links. Although it is seen as an important instrument for addressing other barriers, the (6) **communication of OI benefits** was stated as challenging. So far, established measurement methods for proving the short-, medium- and long-term benefit of OI are missing. Another challenge is (7) **creating success stories.** They are essential for a long-term application of OI in a company. Failures of early OI projects can negatively influence the employees’ perception of OI and hinder subsequent projects (“*scorched earth*” effect).

3.2.3 Results of the SME workshop

In total, the SME workshop yielded 97 issues / idea elements, which can be differentiated into 35 expectations towards OI, 51 concerns against OI and 11 issues addressing both expectations and concerns (for instance, selection of appropriate partners). Since two companies had sent two representatives each, and some elements address more than one of the following clusters, the following results only give a qualitative picture. The single issues are ranked according to the number of corresponding idea elements.

Expectations towards Open Innovation

A major expectation is an (1) **enhancement of internal development capabilities** by external expertise. Another perceived benefit of OI is the (2) **identification of suitable external R&D partners** for solving a task. This is closely linked to a (3) **knowhow enhancement** by external knowledge. Yielding an (4) **external opinion and perspective** is also rated as beneficial for evaluating internal ideas and overcoming patterns of thinking. Along with finding new partners, companies also expect (5) **improved collaborations** with existing partners by using OI.

Concerns against Open Innovation

The main concern against OI is its (1) **industrial applicability**. To address this issue, companies like to have a specified guideline rather than a generic methodology. The (2) **selection of suitable OI partners** along with the (3) **selection of appropriate methods and tools** is considered challenging. Another important issue is (4) **knowhow security** to protect sensitive internal knowledge and data. In addition to identifying OI partners, (5) **selecting efficient incentives** to motivate partners is not trivial. In terms of (6) **internal embedding of OI**, besides motivating external partners, also internal stakeholders need to be motivated to avoid barriers like the NIH syndrome. A sufficient (7) **OI performance assessment and controlling** is seen as s challenge and critical aspect to motivate and convince internal stakeholders. Another concern addresses (8) **law and intellectual properties**. Besides protecting own knowledge, this also involved the treatment of OI input and the risk of inherent property rights (*IP hygiene*). A general issue is the (9) **strategic decision for or against OI** and specific determinant.

3.3 Synopsis of research gaps and resulting focus of dissertation

The overall feedback from the empirical study is positive concerning executed or planned OI activities. The results from the retrospective study and the SME workshop (GUERTLER et al. 2014b) show a strong correlation. Since the SME workshop was particularly focussing on expectations and concerns of companies, the workshop results are more detailed in this regards. Both samples coincide in terms of companies expecting an enhanced knowledge about customers' needs and their markets by applying OI. Common concerns are the risk of an uncontrolled knowledge by opening the innovation process, motivating internal stakeholders, measuring and proving the benefit of OI as well as a long-term implementation in the company.

Companies within the retrospective study stated an **improvement of their PR,** in line with GASSMANN (2013, p. 16), and a **test application** of OI as new innovation concept as important motives for applying OI. The missing test application aspect in the SME workshop might be related to a more cautious behaviour of SMEs due to limited resources that does not allow failures (cf. chapter 2.4). However, the retrospective study also shows the relevance of the success of an initial OI project, in order to create a **success story**. This is crucial for the acceptance by internal stakeholders. Closely linked, a sufficient **processing and operationalisation of OI input** is essential, so internal stakeholders can understand and work with the gained knowledge.

In contrast to the retrospective study, the expectations of the SMEs in the workshop focus more on **enhancing their innovation processes** by external knowledge, competences, capabilities, alternative ways of thinking and improved collaborations with existing partners. A major concern is the **practicality of OI** in their daily business and a missing support of specific **methodical guidelines**, in order to prevent failures. This matches with the impression from the retrospective study that the **majority of OI failures is due to insufficiently planning** activities, such as selecting relevant OI partners, suitable OI methods and considering relevant context factors. Along with a missing differentiation of customers and users of a product and focussing on one group only, this could also mean that phrasings of tasks are changed to "*sound more attractive*" without considering the effects onto type and quality of OI input.

Consolidation of empirical and literature-based industry needs

The comparison of empirical and literature-based industry needs show a high level of correspondence. Interestingly, although the majority of needs, which were identified in the literature analysis, is not new and was already stated a couple of years ago, the empirical study reveals that they are still not sufficiently solved from the perspective of SMEs. The concerns, stated by the workshop participants, are **indicators for potential research gaps**. They are also consistent with the results of the literature-analysis (chapter 2.4.4), the structural analysis of risk interdependencies (chapter 2.3.4) and the retrospective study (chapter 3.2.2), as explained in more detail in the following.

From the SME perspective, the most important need is a **better applicability of OI in industry**. This is in line with the literature analysis, which revealed general need of a systematic process for planning and managing of OI due to the complexity of coordinating the collaboration of different OI partners (BERGMANN et al. 2009, p. 142; DAHLANDER AND GANN 2010, p. 707; GASSMANN et al. 2010, p. 216). HUIZINGH (2011, p. 6) also calls it a "***decent cookbook***" to plan with whom to collaborate, in which ways and for what purpose. In particular, SMEs need methodical support since they have only limited methodical competences and make decisions often spontaneously (MEYER 2013, p. 236f; SPITHOVEN et al. 2013, p. 555). They also have only limited resources (AHSEN et al. 2010, p. 4; MEYER 2005, p. 292) and their existing cooperation are based on trust (HAMER 2013, p. 35). Therefore, an initial OI project has to be an immediate success as wrong decisions can have extensive negative effects (PFOHL AND ARNOLD 2006, p. 19), which also correlates with the results of the structural risk analysis (chapter 2.3.4). In general, the improved industrial applicability represents a superordinate issue, which is enabled by the following research fields.

An enabler for these fields themselves is an (1) **analysis of boundary conditions and constraints**. Although it was not stated by the workshop participants, it is an essential aspect as OI always needs to be adapted to the specific situation and context (DITTRICH AND DUYSTERS 2007, p. 512; GIANIODIS et al. 2010, p. 559; HUIZINGH 2011, p. 4; SOLESVIK AND GULBRANDSEN 2013, p. 15). The analysis of the empirical study also showed that companies often do not sufficiently consider relevant context factors to plan their OI project accordingly. For instance, HOSSAIN (2015, p. 5) states a strong dependency between the goal and potential partners of an OI project. Therefore, companies need support in systematically analysing the goal, relevant boundary conditions and constraints of the intended OI project.

A high ranked need from the workshop is the (2) **identification and selection of suitable OI partners**. In correspondence to the structural risk analysis, also literature states that a central aspect for the success of an OI project is the question, which OI partners are able to create an actual benefit (GIANNOPOULOU et al. 2011, p. 505; HUIZINGH 2011, p. 5). ENKEL et al. (2009b, p. 312) even consider the identification of relevant OI partners a main barrier of OI projects. Usually companies tend to focus on already known OI partners like customers, although they are not useful for the OI project and other stakeholders would be better (BJØRKQUIST et al. 2015, p. 10; GASSMANN AND SUTTER 2008, p. 5; HYLL AND PIPPEL 2016, p. 463). Along with the identification of potential OI partners, it is also important to allow an objective assessment of their suitability (MANOTUNGVORAPUN AND GERDSRI 2015, p. 719). Despite its relevance, the issue is still unsolved and an open research gap as the empirical study showed, and in line with

SOLESVIK AND GULBRANDSEN (2013, p. 11). Therefore, companies need methodical support in identifying and selecting relevant OI partners, as also already indicated by DLR (2013, p. 31).

Closely linked is the (3) **selection of suitable OI methods**, which is the basis of a successful cooperation with the selected OI partners, as different knowledge sources require specific types of collaboration (ILI 2009, p. 94). Wrong types of cooperation are a major source of OI risks, as the structural risk analysis revealed. As the empirical study showed, companies often tend to equal OI with crowdsourcing. Therefore, in accordance to GIANNOPOULOU et al. (2011, p. 513) and HUIZINGH (2011, p. 5), companies need a systematic overview of potential OI methods and support in selecting the most suitable ones for their OI projects.

Along with these active issues, the SMEs of the workshop also stated the reactive need of the (4) **prevention of risks and uncontrolled knowledge drain**. As described in chapter 2.3.4, along with several benefits, OI bears a variety of potential risks for the OI project itself but also the company in general. Within the empirical study, companies named particularly an uncontrolled knowledge drain as a major risk, which is also in line with the structural risk analysis. They stated the need for methods to identify and prevent them. An interview partner stated that an objective highlighting of risks and suitable measures could also lead to a more realistic expectation of OI and even reduce diffuse and often reasonless fears.

Along with the prevention of knowledge drain, SMEs also stated the need of (5) **guidelines for handling intellectual property (IP) rights**. In terms of "*IP hygiene*" this means preventing a contamination of internal IP by protected external IP, which was provided but not sufficiently marked by OI partners (MEYER AND MEYER 2011, p. 92f; PAASI et al. 2010, p. 633). In addition, this includes approaches to deal with blending internal and external knowledge in an OI project, in particular when the achievements of the OI project are likely to touch previously existing IP in the company. Otherwise, OI partners might get the wrong impression of having essentially contributed to a solution, which was actually already existing. Along with this, appropriate strategies for using developed IP and rewarding of OI partners are important.

In addition, workshop participants stated the need of the (6) **selection of appropriate incentive strategies**. In correspondence to the structural risk analysis, a high motivation of all involved OI partners and stakeholders is crucial to ensure a successful and efficient collaboration. Therefore, on the one hand, there is the need of developing measures and incentive strategies to motivate external OI partners to participate in the OI project and share their knowledge with the company. Nevertheless, on the other hand, internal stakeholders like employees are a central success factor for OI (GIANNOPOULOU et al. 2011, p. 508f) as their resistance can cause a variety of risks and barriers like the Not-Invented-Here syndrome (cf. chapter 2.3.4). Hence, incentive strategies for internal stakeholders have also to be considered.

The motivation of internal stakeholders is also a relevant aspect to support the (7) **long-term embedding/implementation of OI within the company**. In accordance with GIANNOPOULOU et al. (2011, p. 519f), companies from the empirical study stated the need of methods that ensure a long-term utilisation within a company. Along with motivational aspects, cultural, administrative and operative aspects need to be considered. This includes the identification and dissolving of barriers and as well as the definition of necessary processes and interfaces to allow a transition of knowledge from the OI project into the innovation process.

Another industry need and important enabler for OI projects and a long-term embedding, is the (8) **assessment and controlling of OI performance and success**, in line with (BRUNSWICKER AND VANHAVERBEKE 2015, p. 1246). It includes the development of appropriate metrics to measure the success of OI (CHESBROUGH AND BRUNSWICKER 2013, p. 30; ENKEL et al. 2009b, p. 314) to prove the benefits of the OI project towards superiors and other employees. This serves as basis for an OI controlling system and ensures a long-term implementation of OI.

A superordinate issue, but of lower priority for the workshop participants, is the need of a (9) **strategic decision support for or against OI**. It directly correlates with a *wrong degree of openness* from the structural analysis of risks. In general, it is necessary to systematically assess and decide, either OI is suitable for a specific company, purpose and project, or if there are serious reasons against the application of OI. This issue is also known as “***readiness for OI***” and an ongoing research topic for OI in general (BEVIS AND COLE 2010; MONTEIRO et al. 2016; WAIYAWUTHTHANAPOOM et al. 2013) as well as of innovation in regional networks (ZERFAß 2005), or focused on innovation readiness of family firms (HOLT AND DASPIT 2015). Nevertheless, this issue has not finally been solved to date.

Figure 3-1 illustrates and summarises the derived research fields and gaps.

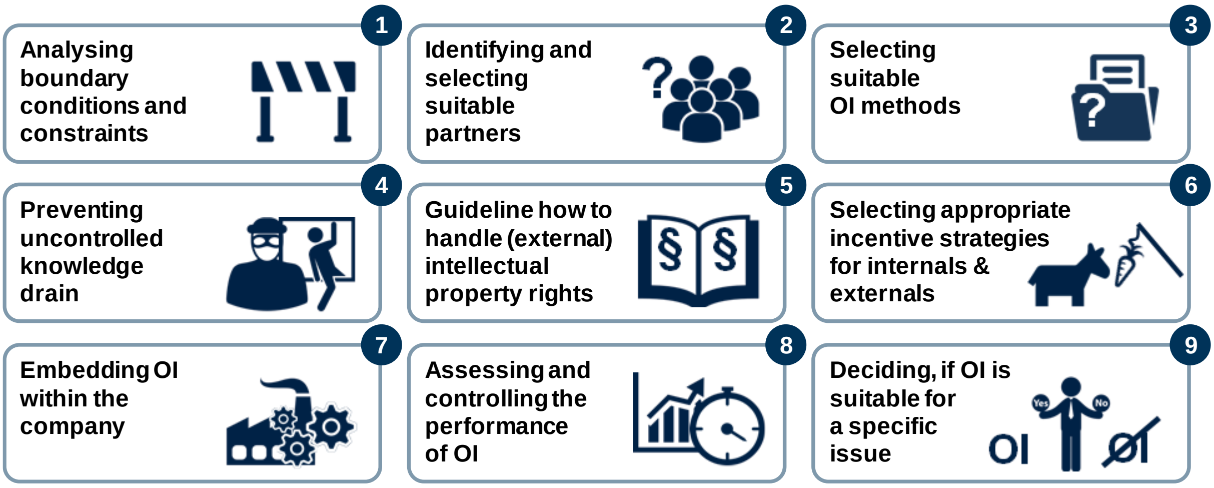

Figure 3-1: Nine industry demands and research gaps of Open Innovation (GUERTLER et al. 2014b, p. 1029)

Focused industry needs within this dissertation

The previous chapters describe the relevance of projects for product development and the application of OI in particular (cf. chapter 2.2.3 and 2.3.1). OI projects are particularly relevant for SMEs without experience with OI. They support an initial or test application of OI due to their defined scope and their decoupling from processes and structures of the company. So, in the case of a failure of the project, these processes and structures are not affected. Nevertheless, an initial OI project has to be successful to convince internal stakeholders of its benefits and avoid torched earth effects. In this respect, a systematic planning of OI projects is essential as the empirical study (chapter 3.2.2) revealed, which is in correspondence with the structural analysis of risks (chapter 2.3.4) and literature (cf. HUIZINGH 2011, p. 6). Mistakes made in this early phase of an OI project can cause long-range effects and risks. They can hardly or only expensively be corrected in a later stage, in accordance to the “*Rule of Ten*” (REINHART et al.

1996, p. 59). Due to the interaction of internal and external stakeholders and processes, OI projects are too complex for ad-hoc approaches. The issue can be summarised as: "*Tell me how you start a project, and I tell you how it will end.*" (GASSMANN 2013, p. 28). Therefore, there is the superordinate **need of methodical support in planning OI projects**. This dissertation focusses particularly on **outside-in OI projects** as it is easier for unexperienced SMEs to gain external knowledge than to publish internal knowledge in the beginning.

As each OI project depends on the specific **OI situation**, the basis for all subsequent planning steps is a sufficient analysis of the goal of the OI project, relevant boundary conditions and constraints. Based on them, relevant OI partners need to be identified to allow the purposeful exchange of knowledge, as stated by CHESBROUGH et al. (2006, p. 1). An insufficient selection of **suitable OI partners** is also a central barrier and risk of OI projects as both, the structural dependency analysis of OI risks (GUERTLER et al. 2015d, p. 6) and the example of the wheel-walker manufacturer from the empirical study show (GUERTLER et al. 2014b, p. 1028). Selecting suitable OI partners itself is not sufficient for the success of an OI project. Depending on the type of OI partners and the OI situation of the OI project, different **ways of collaboration** are appropriate, for instance, due to the global distribution of OI partners or specific needs for secrecy. Thus, the analysis of boundary conditions, identification of relevant OI partners and selection of suitable OI methods represent a basic unity when planning an OI project.

The other research gaps are also important for an OI project. Nevertheless, they depend on the previous three gaps. For instance, **incentive strategies** are directly linked to the OI situation and selected OI partners. OI situation, OI partners and OI methods as combination affect the **controlling system** and the **risk of knowledge drain** by defining the need of concealment, analysing the interests of OI partners and setting the openness and security of the collaboration channel. In addition, the **long-term embedding within the company** also depends on the OI situation and the involvement of internal stakeholders as OI partners. Therefore, these aspects will be addressed within this dissertation but are not in the primary focus. Due to its complexity and multidisciplinary character, the strategic decision of the **general applicability of OI** for a specific company and problem is not addressed. **IP and legal issues** are also not approached as they are far apart from the core competences of an engineering institute.

In summary, this dissertation focusses on the development an **integrated methodology that supports companies in operationally planning outside-in OI project**. As they represent the central elements of an OI project, it particularly focusses on analysing the goal and relevant boundary conditions (OI situation), the identification and selection of relevant OI partners, and the selection of appropriate OI collaboration methods. To develop a holistic model that comprises all relevant aspects of planning an OI project, the **auxiliary research gaps/fields** of preventing uncontrolled knowledge drain, performance measurement and incentives are also integrated into the OI planning methodology. However, they are not considered in detail as they need to be addressed in subsequent research due to their resulting complexity. The planning methodology shall provide a holistic framework that supports SMEs in planning outside-in OI projects to solve engineering problems of a specific product or service.

4. Requirement analysis of methodical support for OI in SMEs

The previous chapter identified and selected three primary research gaps of OI in SMEs, which are focussed within this dissertation. To allow a purposeful development of a planning methodology of OI, it is essential to define requirements of the overall methodology as well as for its single elements, i.e. OI situation analysis, OI partner search and selection of OI methods. On the one hand, requirements are derived by a literature review of explicitly stated requirements and by analysing the characteristics of SMEs. On the other hand, requirements were also collected within a workshop with SMEs. At the end of this chapter, all requirements are consolidated to a consistent requirement list. It serves as orientation for developing the OI planning methodology, and to assess existing partial solutions as well as to evaluate the developed OI planning methodology itself.

4.1 Literature-based requirements analysis of Open Innovation in industry

This chapter derives requirements concerning a methodical support of planning OI projects by the use of a top-down approach: firstly, general requirements of a methodical support in SMEs are analysed, followed by an analysis of general OI-specific requirements and finally, requirements are derived from the characteristics of SMEs (chapter 2.4.3) and their OI-specific success factors and barriers (chapter 2.4.4).

4.1.1 General methodical requirements

General obstacles of the application of methods and methodologies in companies are a perceived high level of abstraction and a **lacking link to specific problems** (GERICKE et al. 2013, p. 2). In addition, methodical support is often **considered as too complex** by industrial users (HUTTERER 2005, p. 16). **Users[19] can be overwhelmed** by a high number of potential methods, which requires a sufficient focussing and highlighting of specifically relevant methods (MEYER 2005, p. 293). Therefore, usability is of high importance for an industrial utilisation. KIRSCHNER (2012, p. 115) states an intuitive application by a variety of users with different competences. This is relevant, since project teams for planning innovation projects should comprise members from different disciplines and departments (LORENZ 2008, p. 150). Hence, on the one hand, a methodology needs to be generic enough to be applicable in different contexts. But on the other hand, it has to provide a **specific process description**, so users in industry can operatively work with it (ALBERS AND MEBOLDT 2007, p. 3; BRAUN 2005, p. 104f; HUTTERER 2005, p. 25).

[19] Users of the methodology are product developers and all employees, who are involved in planning an OI project.

As described in chapter 3.1, OI needs to be adapted to different contexts (HUIZINGH 2011, p. 4). Therefore, a methodology and comprised methods have to be **adaptable** to the characteristics of different industry sectors, companies, processes and products (HUTTERER 2005, p. 16; KIRSCHNER 2012, p. 115; ZANKER 1999, p. 54). Based on the purpose of an OI project, a methodology shall allow **adequate, alternative starting points** (BRAUN 2005, p. 104f). Companies need a guiding framework that is flexible, and allows and supports in forward-backward jumps within the methodology (LORENZ 2008, p. 145). This also includes explicit suggestions of adaptions to prevent the risk that users from industry perceive it as a fix, immutable process (HUTTERER 2005, p. 17f). ZANKER (1999, p. 54) suggests a modular structure of methodology and methods to enable a sufficient adaptability.

Often users lack knowledge of available methods. Therefore, they need an **overview of methods**, including a comprehensive **categorisation** and description to support the understanding and an effective selection of methods (ALBERS et al. 2012, p. 359; HUTTERER 2005, p. 19; MEYER 2005, p. 293). To allow an objective assessment of the methods' applicability, the selection should be based on specific criteria and preferably tool-based (HUTTERER 2005, p. 20). This is also condition for a situation-specific choice and adaption of methods (ZANKER 1999, p. 54). In addition, the pool of methods has to be **extendable by further methods** in the future (BRAUN 2005, p. 104f).

Along with the previous factors, the acceptance by employees is crucial for an application in industry. Therefore, it is necessary to outline the efforts as well as **short and medium-term benefits** of the methodology and methods (ALBERS et al. 2012, p. 359). A common challenge is a benefit lying too far in the future, so users cannot anticipate it, and hence are more likely to reject the methodology (HUTTERER 2005, p. 16). Therefore, efforts as well as direct and indirect benefits (like an improved collaboration of a group) need to be stated (HUTTERER 2005, p. 20; KIRSCHNER 2012, p. 115). **Application examples** can support users in getting a better feeling for the methodology since each method and methodology has intuitive and experience-based elements (HUTTERER 2005, p. 25).

LORENZ (2008, p. 150f) also suggests the implementation of methodologies and methods as **software tools** to increase their usability, as well as **traceability and documentation of processes** and decisions, which is in line with BRAUN (2005, p. 104f) and KIRSCHNER (2012, p. 115). The documentation of the process and decisions is crucial for the success of a project as well as for retrospectively justifying decisions and for a continuous learning process (LINDEMANN 2009, p. 189).

4.1.2 Open Innovation-specific requirements

KIRSCHNER (2012, p. 115) states the need for a holistic and comprehensive methodology, which avoids ***blind spots*** and systematically identifies **all relevant actors**. This is accordance to FREEMAN (2010, p. 28), who states "*you have to focus on all the stakeholders*" of a project. This includes different stakeholder classes (BALLEJOS AND MONTAGNA 2008, p. 296) and the consideration of both, **external and internal actors**, due to the equality of internal and external knowledge (CHESBROUGH 2003a, p. 43). Along with external OI partners, employees and internal stakeholders are crucial for the success of an OI project (GIANNOPOULOU et al. 2011,

p. 508f). They are not only relevant supporters for executing the OI project but are also the subsequent users of the gained outcome of the project. Due to the increasingly broad distribution of knowledge and the need for interdisciplinary collaborations, it is also important to consider worldwide OI partners, and OI partners in other industry sectors (GASSMANN 2006, p. 223f; VAN DE VRANDE et al. 2009, p. 426). However, as it is not possible to involve the entire multitude of stakeholders and potential OI partners, only the most suitable ones should be selected (DE PAULA et al. 2011, p. 355; ENKEL 2009, p. 185; MITCHELL et al. 1997, p. 854; MOSTASHARI 2005, p. 360; SMITH et al. 2011, p. 12). In this respect and in accordance with other authors (chapter 2.3.1), HILGERS AND PILLER (2009, p. 5f) distinguish between knowledge of needs and knowledge of solutions. KIRSCHNER (2012, p. 115) specifically states the technical and cognitive competences of OI partners.

However, as the empirical study in chapter 3.2 revealed, this technical perspective is not sufficient for selecting partners of an OI project (GUERTLER et al. 2014b, p. 1028), which is in accordance to general projects (MOSTASHARI 2005, p. 7). It is important to **identify influential as well as influenced stakeholders** to timely prevent resistance towards the OI project (DE PAULA et al. 2011, p. 356; MOSTASHARI 2005, p. 7). Along with this, interests and interactions between stakeholders need to be considered to avoid low project's performance, failures or even larger "*disasters*" (BALLEJOS AND MONTAGNA 2008, p. 296; BRYSON 2004, p. 23). Understanding the identity and motives of stakeholders is important to balance differing interests (FREEMAN 1984, p. 53; ROWLEY AND MOLDOVEANU 2003, p. 207f) and to derive effective incentive strategies based on specific motives (DENTCHEV AND HEENE 2003, p. 20f). Due to the embedding of companies within networks, and their horizontal and vertical collaborations along the value chain, it is relevant to analyse **dependencies** between potential OI partners and other stakeholders (ENKEL 2009, p. 185; FREEMAN 2010, p. 24; GOULD 2012, p. 5; VAN DE VRANDE et al. 2009, p. 426). Since stakeholder networks, groups and characteristics are continuously changing, these **dynamics** also need to be considered.

To avoid risks like knowledge drain, the OI method and OI project must not give any indications to sensible internal knowledge and should consider measures to **prevent the unintended drain of information** (KIRSCHNER 2012, p. 115). To reduce risks of lacking acceptance of the methodology by employees and objectively prove its benefits, a sufficient performance and success measurement system is necessary. BRANDT (2004, p. 34f) states the need to **consider different perspectives** for a holistic cost-benefit evaluation, such as employees, processes and technologies, and particularly observe learning effects along with a traditional effectivity perspective (PERKMANN et al. 2011, p. 206). This includes the analysis of time and location of sources and effects of innovation activities, dependencies between actors, projects and processes (BRANDT 2004, p. 35; PERKMANN et al. 2011, p. 206). To support users from industry, the number of metrics should be as low as possible and provide reference scales (PERKMANN et al. 2011, p. 211), which correlates with the finding from developing a situation analysis methodology (GUERTLER et al. 2016b, p. 18f). As OI projects are short-term activities and innovations usually show their success in a long-run, a combination of **retrospective and prospective success metrics** is required (cf. PERKMANN et al. 2011, p. 205f). This is the basis for an innovation controlling (HILGERS AND PILLER 2009, p. 8). Clear paths of communication, responsibilities and recipients also have to be defined (HILGERS et al. 2011, p. 85).

4.2 SME-specific requirements derived from SME characteristics

This chapter summarises the insights which can be derived from the characteristics of SMEs (chapter 2.4.3) and the identified success factors and barriers of OI in SMEs (chapter 2.4.4). SMEs need a professional innovation management to develop and manage innovations since they tend to have rather short-termed "*intuitive*" R&D activities (MEYER 2005, p. 292f; PFOHL AND ARNOLD 2006, p. 21). They usually face the pressure of limited resources, and thus to quickly generate revenue from their investments (MEYER 2013, p. 240). This often leads to an insufficient planning and focus on short-term benefits. Nevertheless, they also have no reserves and motivation for trial-and-error approaches and redundancies (ALBERTI AND PIZZURNO 2013, p. 143; MEYER 2013, p. 220). Therefore, project failures can hardly be absorbed (PFOHL AND ARNOLD 2006, p. 18). In addition, insufficiently planned OI projects (for instance, neglecting politically critical OI partners or insufficient awarding of OI partners) can be problematic from a relationship perspective, as collaborations between SMEs and their customers are usually based on trust (HAMER 2013, p. 35). So, failures in OI can negatively affect other collaborations, in the worst case. Along with this, OI also increases the public awareness of the company and can attract or repel new potential employees (LINDERMANN et al. 2009, p. 36f), in line with the empirical study (chapter 3.2.2). Although they therefore need to know and use methods to systematically plan and execute OI projects (MEYER 2005, p. 292f), their methodical expertise is limited in general (AHSEN et al. 2010, p. 4; MEYER 2013, p. 220; SPITHOVEN et al. 2013, p. 555), and particularly in respect to planning and executing an OI project and operationalising its results (RAHMAN AND RAMOS 2013, p. 442). Therefore, SMEs need **methodical support which compensates their limited methodical competences** and allows an **uncomplicated access and operative guidance through the OI planning process**. To avoid unnecessary steps and save limited resources, the planning methodology needs to be adaptable to the characteristics of each OI project, and the expertise of the users of the methodology.

When searching for external project partners, SMEs have usually a narrow search breadth and tend to focus on already known partners (ALBERTI et al. 2014, p. 38). The entrepreneurs can draw on a tight network of suppliers and customers (AHSEN et al. 2010, p. 4). In general, networks are of high relevance to SMEs (LEE et al. 2010, p. 291; VAN DE VRANDE et al. 2009, p. 426; WELTER et al. 2014a, p. 22). Therefore, along with the need of a **systematic search for OI partners beyond the usual suspects**, these **networks** have to be considered when planning an OI project and searching for OI partners.

As already described for OI in general, potential OI partners need to be assessed regarding their **operative technical expertise and capabilities**, as one of the main motives of OI is the utilisation of external knowledge, R&D capabilities and resources (ASCHEHOUG AND RINGEN 2013, p. 3; BRINK 2014, p. 20; BRUNSWICKER AND VANHAVERBEKE 2015, p. 1243; LINDERMANN et al. 2009, p. 35; SALVADOR et al. 2013, p. 366; VAN DE VRANDE et al. 2009, p. 432; VANHAVERBEKE et al. 2008, p. 256). In addition, potential OI partners have to be evaluated from a **strategic political perspective** to allow a holistic view on OI partners. The knowledge about an OI partner's interests is important since OI also means to share innovation risks (CARVALHO AND MOREIRA 2015, p. 13). Lacking knowledge about OI partners is a main barrier of OI in SMEs (LINDERMANN et al. 2009, p. 36), particularly a lacking understanding of the OI partners' business model and their role within the OI project (BRAUN 2015, p. 70). Knowing the OI partners' interests and dependencies to other actors is also important in terms of **IP protection**. This is relevant as SMEs primarily profit from selling products and services, which might be copied or imitated by others (SPITHOVEN et al. 2013, p. 556).

Despite the external partners, **employees are still the most important resource** of SMEs due to their motivation and engagement (PFOHL AND ARNOLD 2006, p. 21). The appreciation of their achievements is a major motivation factor for employees (HAMER 2013, p. 35). Therefore, companies have to consider and involve employees in an appropriate way when planning and executing an OI project. This also includes a clear statement and **communication of the benefits and limitations** of OI and of the planning methodology. This supports in preventing wrong expectations and a feeling of threat and resulting resistance from the employees as well as lacking commitment from managers and employees (HAMER 2013, p. 35; 2013; RAHMAN AND RAMOS 2010, p. 480) and refusal of changes and alterations (MEYER 2013, p. 239).

According to ADERHOLD AND RICHTER (2006, p. 10), an insufficient documentation of processes, intermediate results and decisions can also have a negative effect onto the innovation capacities of SMEs. Along with an ongoing utilisation of these documents for project controlling and a retrospective analysis in terms of a continuous learning process, the documentation is also helpful for introducing new team members or other employees into the goal and setup of the OI project.

4.3 Empirical requirements study in industry

The requirements, collected in a workshop with three SMEs, particularly address operative requirements of the OI planning methodology. To avoid the traditional "*requirements triad*" of low costs, fast execution and good quality of results (KIRSCHNER 2012, p. 99), the companies were confronted with requirements categories, which they should fill with specific requirements. Detailed questions in respect to the effort are excluded here since the stated effort varies from hours to days, depending on the specific company.

In summary, the SMEs like to have a methodology which is intuitively usable and does not require specific expertise in OI to be able to use the methodology. The methodology should describe the planning process but should also indicate points for scaling and adapting. This is relevant to allow an application of the methodology in differing company and project contexts, along with using specific methodical elements for alternative, not OI-specific purposes. In addition, the methodology should provide methods kits that comprise different alternative planning methods and OI methods. In terms of selecting suitable methods, the companies stressed the importance of a transparent ranking of methods, which shows all and do not filter them. In this respect, advantages, disadvantages and contra-indicators of methods should be highlighted. By this, the exclusion of principally suitable methods shall be prevented, which are excluded due to easily adaptable criteria. To ensure its usability in industry, the methodology should be as comprehensible as possible and provide exemplary application cases. In addition, it should state the specific efforts and benefits of each planning activity, to increase the acceptance by employees. Users should also be sensitised for potential barriers and threats, which might occur and risk the success of an OI project.

4.4 Synopsis of requirements for Open Innovation planning methodology

This chapter summarises the previously presented requirements within consistent requirement lists. These serve as orientation for developing the methodology for planning OI projects as well as basis for its subsequent evaluation in industry. The requirements are clustered in general requirements of the methodology and requirements which focus on specific elements of the planning methodology. The latter are also used to assess existing methodical support in the regarding areas. An asterisk (*) indicates requirements which were also derived from the empirical requirement analysis.

Table 4-1: General requirements of OI planning methodology

Usability in industry
Operative guidance for inexperienced users* (Albers and Meboldt 2007, p. 3; Braun 2005, p. 111; Hutterer 2005, p. 25; Kirschner 2012, p. 115)
Flexibility and adaptability for experienced users* (Braun 2005, p. 112; Hutterer 2005, p. 25)
Applicability in different project contexts
Consideration of the boundary conditions of the company and project (Huizingh 2011, p. 4)
Allow a variation of phases* (Braun 2005, p. 104f; Lorenz 2008, p. 145)
Allow scaling of methodology* (Zanker 1999, p. 54)
Allow adapting the methodology* (Huizingh 2011, p. 4; Hutterer 2005, p. 17f; Zanker 1999, p. 54)
Long-term embedding in companies
Description of the purpose and goal of elements of the methodology to increase acceptance by users* (Albers et al. 2012, p. 359)
Minimise effort of data-based redundancies and effort of data handling (source: industry partners)
Description of efforts and benefits of the methodology* (Albers et al. 2012, p. 359; Hutterer 2005, p. 20; Kirschner 2012, p. 115)
Prevention of project failures
Ensuring a homogenous knowledge level within the OI team (Lorenz 2008, p. 150)
Ensuring a systematic procedure (Albers and Meboldt 2007, p. 3; Kirschner 2012, p. 115)
Sensitising for potential barriers and risks of OI* (Kirschner 2012, p. 115)
Fostering interdisciplinary collaborations (Lorenz 2008, p. 150)
Traceability
Ensure traceability and transparency of process and decisions (Braun 2005, p. 104f; cf. Gassmann and Sutter 2008, p. 42f; Lorenz 2008, p. 150f)
Documentation of process and decisions (Albers and Meboldt 2007, p. 3; Lindemann 2009, p. 189)

Table 4-2: Requirements of analysing an OI situation

Analysing an OI situation
Consideration of internal influencing factors* (HUTTERER 2005, p. 16; KIRSCHNER 2012, p. 115; ZANKER 1999, p. 54)
Consideration of external influencing factors* (HUTTERER 2005, p. 16; KIRSCHNER 2012, p. 115; ZANKER 1999, p. 54)
Consideration of existing collaboration experience* (AHSEN et al. 2010, p. 4)
Ensuring the measurability of analysis criteria* (GUERTLER et al. 2016b, p. 19)

Table 4-3: Requirements of selecting OI partners

Selection of OI partners
Consideration of external stakeholders (CHESBROUGH 2003a, p. 43; FREEMAN 2010, p. 28; KIRSCHNER 2012, p. 115)
Consideration of internal stakeholders (CHESBROUGH 2003a, p. 43; FREEMAN 2010, p. 28; GIANNOPOULOU et al. 2011, p. 508f; KIRSCHNER 2012, p. 115)
Supporting the identification of OI partners from a known pool of actors (DE PAULA et al. 2011, p. 355; MITCHELL et al. 1997, p. 854)
Supporting the identification of unknown new potential OI partners* (GASSMANN 2006, p. 226; KIRSCHNER 2012, p. 115; VAN DE VRANDE et al. 2009, p. 426)
Consideration of an operative technical perspective (GUERTLER et al. 2014b, p. 1028; HILGERS AND PILLER 2009, p. 5f; KIRSCHNER 2012, p. 115)
Consideration of a strategic perspective (DE PAULA et al. 2011, p. 356; FREEMAN 1984, p. 53; GUERTLER et al. 2014b, p. 1028; MOSTASHARI 2005, p. 7; ROWLEY AND MOLDOVEANU 2003, p. 207f)
Consideration of stakeholder dependencies and networks (BALLEJOS AND MONTAGNA 2008, p. 296; BRYSON 2004, p. 23; ENKEL 2009, p. 185; FREEMAN 2010, p. 24; GOULD 2012, p. 5; VAN DE VRANDE et al. 2009, p. 426)

Table 4-4: Requirements of selecting OI methods (cf. GUERTLER et al. 2015a, p. 8)

Selection of OI methods
Supporting the selection decision* (HUTTERER 2005, p. 19; MEYER 2005, p. 293)
Ranking OI methods regarding their situation and partner suitability* (cf. HUIZINGH 2011, p. 4)
Ensuring transparency of the ranking process* (BRAUN 2005, p. 104f; LORENZ 2008, p. 150f)
Showing advantages and disadvantages of each OI method* (ALBERS et al. 2012, p. 359; ZANKER 1999, p. 54)
Allowing a future enhancement by further OI methods(BRAUN 2005, p. 104f)
Ensuring an intuitive use of the selection approach* (ALBERS et al. 2012, p. 359; BRAUN 2005, p. 111)
Allowing a criteria- and software-based selection process (HUTTERER 2005, p. 20, 23)

5. State of the art of methodical support for Open Innovation projects

The following chapter gives an overview of the state of the art of planning OI projects, which suffers some shortcomings, as showed in detail. Therefore, this chapter subsequently identifies alternative existing approaches for each of the previously prioritised research gaps. As SME-specific approaches are limited, general ones are considered. Nevertheless, all approaches are analysed concerning the defined SME-specific requirements. This allows an evaluation either sufficient methodical support do exist for specific gaps or specifically indicates open needs for additional support. It also serves as basis of deriving the OI planning methodology by indicating how elements of existing approaches can be adapted and combined with newly developed elements.

5.1 Existing approaches for planning Open Innovation projects

Chapter 3 identified the industry need for methodical support in planning OI projects with a particular focus on the research gaps of analysing relevant context factors, identifying OI partners and selecting OI methods. This chapter identifies and analyses existing approaches for planning OI projects in literature. Although the required methodology for planning OI projects particularly focusses on supporting SMEs, the regarding SME-specific methodical support is limited, as shown in chapter 2.4.4. Therefore, in this chapter, it is necessary to broaden the scope of analysis to methodical support of OI in general. Nevertheless, the assessment of these approaches is conducted regarding the SME-specific requirements from chapter 4.4.

To structure the regarding literature, existing structures from other authors were analysed. For instance, KOVÁCS et al. (2015, p. 970) differentiate publications describing the concept of OI, knowledge sourcing (i.e. outside-in OI), external commercialisation (i.e. inside-out OI), OI in specific industries, specific forms of OI (e.g. user-centric OI and ideation contests) and implementation mechanisms and tools. In addition, SALVADOR et al. (2013, p. 360f) distinguish literature regarding the research method (quantitative, case studies), company focus (SMEs, MNEs), industry sector, geographical location and "*content features*" (theoretical or practical focus). Another differentiation criterion is the specific phase of OI that the publications are addressing. In line with the *map of Open Innovation*, as presented in Figure 1-1, four phases of OI projects can be distinguished: (1) *initiation* (i.e. strategic decision for OI), (2) *planning*, (3) *execution* and (4) *integration* of gained knowledge into the innovation process.

Table 5-1 summarises these differentiation criteria to a consistent classification framework of OI support in literature[20]. It distinguishes publications regarding the addressed **size of companies**, the **innovation object** that is supported or improved by using OI, the **type of support** which ranges from rough explanations of OI via support in decision making to a long-

[20] The framework is based on results of the supervised theses of PE: SCHNEIDER (2014) and PE: HAYMERLE (2015).

term change management support, and the **focus of support** that can address OI holistically or, for instance, focus on specific OI methods or OI partners. The **level of detail** specifies the support if it just provides an abstract overview of what to do, or also detailed instructions of how to do it as an operative guideline, or if it presents only descriptive results from quantitative and qualitative studies. The **type of OI** characterises the publication in respect to the direction of exchanged knowledge flow. The **phase of OI** is conform to the previous description.

Based on the conclusion of chapter 3.3, the focus of the OI planning methodology of this dissertation is highlighted. It aims at supporting SMEs in planning outside-in OI projects, in order to solve innovation problems and tasks of specific products and services. The methodical guideline provides operative help.

Table 5-1: Classification of methodical support in literature and highlighted focus of this dissertation

Criteria	Specifications				
Size of company	**small enterprises**	**medium enterprises**	large enterprises	N/A	
Innovation object	entire company	**specific products**	**specific services**	specific processes	
Type of support	overview of OI	**selection / decision making**	application	long-term implementation	
Focus of support	**entire OI**	specific OI methods	specific OI partners	incentives	performance measurement
Level of detail	general overview	abstract directions	**operative guideline**	quantitative study report	case study report
Type of OI	**outside-in**	inside-out	coupled		
Phase of OI	initiation	**planning**	execution	integration	

In terms of the following literature analysis, the type of support, the focus of support and the level of detail proved to be the most distinguishing ones. Therefore, the **following approaches are structured according to the following derived categories**: (1) papers conceptualising OI and presenting study results, (2) papers comprising abstract directions for planning OI, (3) papers focussing on specific OI partners or OI methods, and (4) papers addressing a long-term implementation of OI.

However, often publications address more than one category, for instance, case studies analysing supplier cooperation. In those cases, the publications are assigned to the category that seems more relevant concerning the goal of this dissertation. In respect to the type of OI, this dissertation focusses on outside-in OI and therefore excludes inside-out-specific approaches. SME-specific publications are limited (cf. also chapter 3) and mainly address the first cluster of OI concepts and studies.

5.1.1 (Case) studies and overview of Open Innovation

This group comprises publications with rather indirect recommendation for planning OI projects. These can be clustered in three sub-groups. The first sub-group comprises publication which introduce the **concept of OI,** such as CHESBROUGH (2003a), CHESBROUGH et al. (2006) and CHESBROUGH et al. (2014), and approaches for better understanding and **structuring OI**. HUIZINGH (2011) provides an overview of OI, selected structuring approaches and rough topics to consider when planning OI projects. Exemplary categorisation approaches are the direction of knowledge flow by GASSMANN AND ENKEL (2004), locus of innovation by CHESBROUGH AND CROWTHER (2006), four OI strategies of GIANIODIS et al. (2010), four modes of OI (LAZZAROTTI AND MANZINI 2009), IP ownership (HOWARD et al. 2012) and degree of openness (BAHEMIA AND SQUIRE 2010; VERBANO et al. 2015). FÜLLER et al. (2015) present an ontology to characterise knowledge from customer input in particular. The majority of these publications also comprise a qualitative or quantitative study to derive or evaluate the presented structuring approach.

In addition, the second sub-group presents **case studies** focussing on specific companies and industry sectors. For instance, BILGRAM et al. (2013) describe the case of Beiersdorf developing new deodorant by using different OI methods, such as netnography and Lead-User workshops. Similar is the description of the implementation of Procter and Gamble's "*Connect and Development*" program (HUSTON AND SAKKAB 2006; 2007). Along with specific OI initiatives, JÖRGENSEN et al. (2011) also present the results of a case-study analysing inter-firm collaboration in the fuzzy front end.

In contrast to case studies, the third sub-group comprises **quantitative studies**, which analyse specific factors and their influence on OI. For instance, LAURSEN AND SALTER (2006) analyse the effect of external search breadth and depth onto the innovation performance of companies, while LEE et al. (2010) focus on the influence of intermediary networks on Korean companies, and BUGANZA et al. (2011) on the effect of industry characteristics onto the application of OI. SALGE et al. (2012) aims at identifying company-internal success factors of OI, such as degree of openness and absorptive capacity aspects. VAN DE VRANDE et al. (2009) particularly observe the application of OI in SMEs. LINDEMANN AND TRINCZEK (2011) retrospectively analyse external collaborations regarding success factors and barriers. Along with these publications, there are several papers focussing on supplier cooperation, such as suppliers of the mobile phone industry (REMNELAND-WIKHAMN et al. 2011), the influence of technical and behavioural antecedents on innovativeness and pricing (SCHIELE et al. 2011), and the role of knowledge and IP management in customer supplier collaborations (PAASI et al. 2010).

This group of publications are useful to get an **overview of different types of OI** and **exemplary application cases** in specific companies, as presented in chapter 2.3 and 2.4.4. While the structuring approaches can help in locating the own OI activities, the results of the quantitative and qualitative studies can provide rough indications of dependencies between influencing factors and OI activities (chapter 2.4.4). However, these publications do not provide prescriptive guidance and the reader needs to interpret the results and combine it with other results and own expertise.

5.1.2 Abstract directions for planning Open Innovation

DIENER AND PILLER (2010) present a description and rough recommendations what to consider when companies intend to apply an ideation contest, a broadcast search and the Lead-User approach, and commission an intermediary. ILI (2010) describes six phases, including activities and questions, that need to be considered when planning an OI project and a long-termed implementation of OI. Focussing on evaluating the market potential of innovative ideas, FETTERHOFF AND VOELKEL (2006) present an abstract guideline for planning an OI project that gives tips for selecting OI partners and OI methods. Particularly for SMEs, SCHWAB et al. (2011) develop a framework, which characterises companies concerning the dimensions humans, organisation and technology, to derive suitable OI methods. However, specific characteristics within the dimensions and their influence on OI methods are only vaguely mentioned. VOLLMANN et al. (2012) also only abstractly describe how to select and motivate external OI partners, whereby they focus primarily on customers. Along with them, COLOMBO et al. (2011) analyse how "*service suppliers*" can plan and organise OI projects for their customers. Although they state phases and approximate durations, the phases and their contained activities are only roughly explained. From a more general knowledge management perspective, WALLIN AND KROGH (2010) present a five-step process for planning OI projects, including the identification of external knowledge and its integration.

In summary, these group of publications describe **what** companies need to consider when planning OI projects. Nevertheless, they hardly provide any operative information of **how** to do this in detail.

5.1.3 Approaches focussing on specific OI partners or OI methods

A large part of literature specifically addresses different aspects of **crowdsourcing**, with usually customers. While BONNER (2011) only mentions general strategies, REICHWALD AND PILLER (2009, pp. 124–162) support in planning crowdsourcing projects with customers, but also more on an abstract guideline level. PILLER AND IHL (2010) combine a typology of crowdsourcing partners with exemplary case studies and recommendations for CS-specific competences of the company. A more specific guideline for planning crowdsourcing projects is introduced by GASSMANN (2013) The guideline comprises five phases, ranging from a preparation phase, via an execution phase to an exploitation phase. In addition to central activities of each phase, reflexive control questions and tips for potentially occurring risks are stated. PANCHAL (2015) present an alternative three-step framework for planning crowdsourcing projects. However, along with a solely focus on crowdsourcing, the description of activities still stays abstract in both cases. Other publications address specific OI methods can be identified, for instance, **ideation contests** (WALCHER 2007) or **toolkits** (FRANKE et al. 2008; HIPPEL AND KATZ 2002; PILLER et al. 2010; PILLER AND WALCHER 2006). Along with LEIMEISTER AND KRCMAR (2006) and EBNER et al. (2009), BLOHM (2013b) and EBNER (2008) develop a guideline for planning, implementing and managing **OI communities**, while MAUL (2015) and WENDELKEN (2015) specifically focus on company-internal innovation communities. ZYNGA (2015) focusses on organisational success factors of broadcast searches within communities, hosted by OI intermediaries. In addition to CS-specific publication, there are also authors focussing on **collaborations with smaller groups** of external OI partners. For instance, BERGMANN et al. (2009) present a four-step process for planning and executing inter-organisational workshops but also focus primarily on what to do and not how to do it. In contrast, ASCHEHOUG AND RINGEN (2013) empirically analyse success factors for generating innovative ideas in inter-organisational workshops.

In summary, although these publications focus on specific OI partners and OI methods, they show the same shortcomings as the previous groups: descriptive study results, structuring frameworks, or abstract guidelines, that focus on which activities should be done but not how.

5.1.4 Long-term implementation-focussed approaches

CHIARONI et al. (2011) present an abstract guideline for implementing OI within a company by adapting the three core phases of change management by LEWIN (1947), i.e. ***unfreezing***, ***moving*** and ***institutionalising***, and identifying central levers for the change process. In accordance to BOSCHERINI et al. (2010) and CHIARONI et al. (2010; 2015), they consider OI itself an organisational innovation. In this respect, pilot projects are of high relevance since companies can gain first experience with OI without risking to large negative effects in the case of a failure. ENKEL et al. (2011) develop an OI maturity framework to access the company-specific current and target level of OI, in order to allow an effective implementation of OI.

In summary, these publications focus on change management and implementing OI on a company level. However, the specific implementation guidelines are still relatively abstract.

5.1.5 Conclusion of the state of the art of planning OI projects

As the results of the literature review show, there exists no holistic approach for planning OI projects as characterised in Table 5-1. The majority of publication serves for improving the understanding of OI. These studies are either focussing on very specific case studies or a quantitative analysis of specific OI features, often on an abstract economic level. All of them have a descriptive character, which does hardly give prescriptive recommendation for planning OI. Existing prescriptive publications have the shortcoming of usually being too abstract, i.e. they state **what** to do when planning an OI project but not **how** to do it. More detailed guidelines tend to focus on particular OI partners or OI methods but lack a holistic planning perspective. Other publications address a long-term implementation of OI in companies but mainly focus on change management aspects and excludes project-specific aspects. Hence, a holistic approach for planning OI projects does not exist, which addresses all selected research gaps from chapter 3.2.3. Therefore, it is therefore necessary to have a closer look into the single research gaps to identify existing partial approaches. These partial approaches of context and situation analysis, OI partner search and OI method selection are the basis for the subsequent development of a holistic OI planning methodology. In the following, for each research gap existing approaches are analysed concerning the requirements derived in chapter 4. Since an initial screening showed that OI-specific approaches are not sufficient to fulfil all requirements, in addition, established approaches from other disciplines are identified and analysed.

5.2 Approaches for analysing the context situation of Open Innovation projects

The following section is based on the intermediate results presented in GUERTLER et al. (2016b). The situation-specific planning and executing of Open Innovation projects is essential for their success (DITTRICH AND DUYSTERS 2007, p. 512; HOSSAIN 2015, p. 5; HUIZINGH 2011, p. 5; LOREN 2011, p. 10; SOLESVIK AND GULBRANDSEN 2013, p. 15; ZERFAß 2009, p. 40). This correlates with statements from product development (BIRKHOFER et al. 2002, p. 18; GERICKE et al. 2013, p. 1; LINDEMANN 2009, p. 29; PONN 2007, p. 43). For instance, BIRKHOFER et al. (2005, p. 9f) declare within their ***10 Commandments*** for product design that it is essential to "*meet the design situation*" to effectively and efficiently choose and execute approaches, methods and tools. This requires an appropriate determination of the specific situation.

However, this is also a great challenge since situations are **highly dynamic** (PONN 2007, p. 43) and the related literature is scattered since varying terms are used by different authors, e.g. ***situation*** (FABRIZIO 2006, p. 158; HALES AND GOOCH 2004, p. 1; PONN 2007, p. 43), ***boundary condition*** (ALBERS AND BRAUN 2011, p. 11), context (GERICKE et al. 2013, p. 1; HALES AND GOOCH 2004, p. 1, 9f), ***context factors*** (GIANIODIS et al. 2010, p. 554), ***influencing factors*** (HALES AND GOOCH 2004, p. 39) etc. Therefore, it is necessary to consider the field of situation analysis from a broader perspective to reduce the risk of missing relevant approaches. Thus, approaches also from product development and general innovation management are reviewed.

Although it considers different terms for the literature review, this dissertation uses the term "**situation"** to allow a consistent utilisation. The following literature analysis has been pre-published in GUERTLER et al. (2016b).

5.2.1 Definitions of Open Innovation situations in literature

The basis of a situation analysis is a consistent understanding and definition of the term "***situation***" to allow a purposeful determination of situation criteria, which distinctively characterise a situation. So far, a consistent definition of "***Open Innovation situation***" is missing in the literature. Generally, only abstract statements about "situations" can be found, such as: "*A blanket approach (...) is unlikely to provide an optimal solution to these trade-offs, because each technology and market situation is different.*" (FABRIZIO 2006, p. 158). BECKER AND ZIRPOLI (2007, p. 6) even call OI itself a situation: "*Because the 'open innovation' situation (...)*". Looking at the broader term "innovation situation" does not reveal a distinctive definition either, but rather abstract statements about situations (GUERTLER et al. 2016b, p. 8). Thus, it is necessary to have a look at a general definition of a *situation* and a *design situation*.

General definition of situation

Based on BROCKHOFF (1996, vol. 20, p. 274), PONN (2007, p. 44) **defines a situation** as "*a state or sum of all current circumstances and relationships*", referring to the Latin word "*situs*", meaning position and condition. Another closely related term is "*context*", which is defined as "*coherence, background and periphery*", based on the Latin verb "*contextere*", meaning to closely link (BROCKHOFF 1996, vol. 12, p. 328).

Design Situations

In product development, the term "***design situation***" is used (PONN 2007, p. 44), based on DEMERS (2000, p. 3), HUTTERER (2005, p. 29) and ZANKER (1999, p. 4). LINDEMANN (2009, p. 336) presents a general definition by: "*A situation is **a point in the development process**, which requires corresponding actions and decisions by the product designer; **influenced by a multitude of factors** (personal influencing factors, type of task and demanded results, external boundary conditions)*" (translated from German). In the English literature, a design situation is defined as (REYMEN 2001, p. 56): "*(...) the **combination of the state of the product** being designed, the **state of the design process**, and the **state of the design context** at that moment. This means that it is the **set of values of all properties** describing the **product** (...) the **design process**, and (...) **all factors** influencing the product being designed and its design process*". In accordance with PONN (2007, p. 43), he also stresses the dynamic character of a situation, which changes over time (REYMEN 2001, p. 52f). In addition, he mentions some specific criteria, such as "*budget*" and "*maximum duration*" (REYMEN 2001, p. 85). As indicated by LINDEMANN (2009, p. 336), a design situation can be analysed on **different levels** and **perspectives**, such as a strategic long-term level, a project-specific medium-term level, and an operative short-term level (MEIßNER et al. 2005, p. 73). Besides normal design situations, also special cases, such as critical situations, can be found (BADKE-SCHAUB AND FRANKENBERGER 2004).

5.2.2 Descriptions of Open Innovation situations in the literature

Although, the term OI situation (and its synonyms) is not defined in literature, some authors address the issue of evaluating innovation situations. For instance, SARKKINEN AND KÄSSI (2013, p. 4) define four categories, including specific values for assessing and characterizing the innovation situation of companies in rural regions of Finland: (1) innovation activities, (2) innovation types, (3) innovation goals, and (4) innovation barriers. KLINE AND ROSENBERG (1986) focus on the innovation production process with their ***Chain-Linked Model of innovation***. This was later expanded on by MICAËLLI et al. (2014), who focus on an innovation system, which they consider to be a "*network of complementary components (actors, processes, institutions, etc.)*" in different geographical and juridical contexts (MICAËLLI et al. 2014, p. 60).

In general, there exist different types of publications which address the issue of *(open) innovation situations*, as presented in GUERTLER et al. (2016b). Some sources contain explicit criteria and suitable specification scales (e.g. *form of governance* (BEVIS AND COLE 2010, p. 6)). Others only state rough criteria without indicating any specifications and therefore can only be used as indication for suitable criteria (e.g. *centrality of R&D* (GASSMANN et al. 2010, p. 213), *company culture* and *hierarchies* (PONN 2007, p. 55) or *innovativeness* (HAUSCHILDT AND SALOMO 2007, p. 493)). Common sources are also case studies, which describe specific OI projects and can also be used for deriving situation criteria, e.g. HIPPEL (1988). A special case is the work by GERICKE et al. (2013), who analyse various definitions of the term "***context***". They present a large collection of different influencing factors, which might be relevant for the adaption of design methods. However, they do not present detailed information about the criteria, their specific relevance nor their origin. ROTHE et al. (2014) present an approach for selecting OI methods including 14 selection criteria, which can also be used for describing an OI situation. However, the criteria only contain quasi-binary specification scales.

In addition, publications can be categorised according to their superior topics, which correlate with the categories from chapter 5.1: abstract process plans for implementing OI, Quantitative empirical studies and case studies, and papers focussing on specific aspects of OI. In addition, a further category comprises publications with a **broader focus of innovation management aspects**, such as inter-firm collaboration (Hagedoorn 2002; Hagedoorn and Cloodt 2003), absorptive capacity (Blohm 2013b; Cohen and Levinthal 1990; Schmidt 2005), and the relationship between innovativeness and performance (Hauschildt and Salomo 2007). This category also consists of publications that address the company strategy (Porter 1985, p. 11f) and human resource management (Rastetter 2006), since Ertl (2010, p. 62) stresses the importance of the strategic goal and environment of an innovation project. A detailed overview of different situation criteria, which were extracted from the previous publications, is presented in the appendix 13.4 and in Guertler et al. (2016b).

5.2.3 Evaluative summary of analysing Open Innovation situations

The previous chapters showed the lack of a consistent definition of an OI situation and a variety of synonyms of the term situation, such as boundary condition or context. A general analysis of definitions of “situation” and “design situation” revealed the following characteristics (Lindemann 2009, p. 336; Ponn 2007, p. 44; Reymen 2001, p. 56): (1) **state at a specific point**, with (2) **multiple perspectives**, such as product, design process and design context, which is (3) described by a **set of criteria and specifications**.

The characteristic “***state***“ indicates a main challenge of situation analyses in terms of the high dynamic of a situation (cf. Ponn 2007, p. 43). Another challenge is the common lack of distinctiveness as well as reasonable specification scales and assessment methods of situation criteria. Often only indirect indications of criteria and specification scales can be found in literature. Therefore, situation criteria from other disciplines were identified to enhance this limited set of suitable OI criteria. Hence, the OI relevance, measurability and usability in industry need to be evaluated subsequently.

Table 5-2 summarises the degree of fulfilment of the presented approaches in respect to the requirements of a SME-specific OI situation analysis. The existing approaches address a company-internal and external perspective but lack a deeper consideration of experience with previous collaborations. Due to their varying level of detail and often lack of specification scales, their measurability is rather limited.

Table 5-2: Requirement analysis of existing situation analysis approaches

Analysing an OI situation	
Consideration of internal influencing factors	●
Consideration of external influencing factors	●
Consideration of existing collaboration experience	◔
Ensuring the measurability of analysis criteria	◔

5.3 Approaches for identifying and selecting Open Innovation partners

This chapter analyses established approaches for identifying relevant project partners. It combines approaches from OI as primary field of research with approaches from User Innovation (i.e. in particular Lead User identification) due to its thematic proximity, and stakeholder analysis due to its strength in assessing a strategic perspective and complex network structures with multiple actors (GOULD 2012; GUERTLER et al. 2013). These major approaches are enhanced by alternative search methods for identifying different types of partners.

5.3.1 Open Innovation related approaches

General aspects and studies concerning the search for OI partners

While FETTERHOFF AND VOELKEL (2006, p. 18) stress the general importance to recruit suitable external partners, CHIARONI et al. (2010, p. 241) state the **central role of the responsible manager and his social network** when applying OI the first time in a company and searching for OI partners. In general, **three main search strategies** can be differentiated: (1) a **proactive** contacting by OI partners, (2) a **self-selection** by OI partners based on an invitation of the company, for instance, on platforms or toolkits, and (3) an **active search** by the company (BOGERS AND WEST 2012, p. 68). This is in line with PHILLIPS (2011, p. 23), who sees the advantages of a **company-active search** in tasks that require specific knowledge and experience, projects with high need of secrecy, aiming for patentable IP and radical innovations. A **self-selection of OI partners** usually provides a larger amount and more diversified actors. In this respect, MCFATHING (2011, p. 183f) stresses the importance to attract the right OI partners by ensuring the public awareness of the invitation for participation and a good company PR. OI partners need the feeling that their participation can create a benefit (VOLLMANN et al. 2012, p. 78f). PHILLIPS (2011, p. 25) structures OI partner involvements concerning the type of instructions (*none vs. directed*) and broadness of invitations (*relatively few vs. everyone*).

Based on the empirical analysis of 1411 SMEs, BRUNSWICKER AND VANHAVERBEKE (2015, p. 1251) develop a **typology of strategic OI partner searches**: (1) ***minimal searcher***: with no active interaction with externals, (2) ***supply chain searcher***: primarily interacting with customers and suppliers, (3) ***technology searcher***: focussing on latest research results by frequently cooperating with universities, research institutes, IPR experts and innovation networks, (4) ***application-oriented searcher***: focussing on direct applicability of knowledge by cooperation along the value chain, and (5) ***full-scope searcher***: cooperating with various OI partners from different knowledge domains. In particular, the full-scope strategy offers the most opportunities by using different knowledge sources. The application-oriented strategy increases the market success by accessing customers. Similarly, HENTTONEN AND RITALA (2013) empirically examine the influence of different search approaches onto 762 Finnish companies. They distinguish a "*focused search strategy*" and a "*multi-focus search strategy*", which they further sub-divide into **four knowledge search strategies**. They found that an external search has a generally positive effect on a company's innovation performance, whereby the multi-focus search shows a stronger effect. In particular, **heterogeneous knowledge sources** can result in a better differentiation from competitors and in competitive advantages. However, they do not analyse, **how** the companies search for knowledge, and which sources they use in detail.

In general, LAURSEN AND SALTER (2006, p. 143f) empirically analysed the **optimal search breadth and depth**. As shown in Figure 5-1, the optimal search breadth is between 9 and 13 involved external sources, while the optimal search depth are three intensively involved sources. In line with ILI AND ALBERS (2010, p. 50), LINDEMANN (2009, p. 24) and MOSTASHARI (2005, p. 360), a growing knowledge base and synergy effects lead to an increased innovation performance, which then decreases due to coordination and supervision efforts.

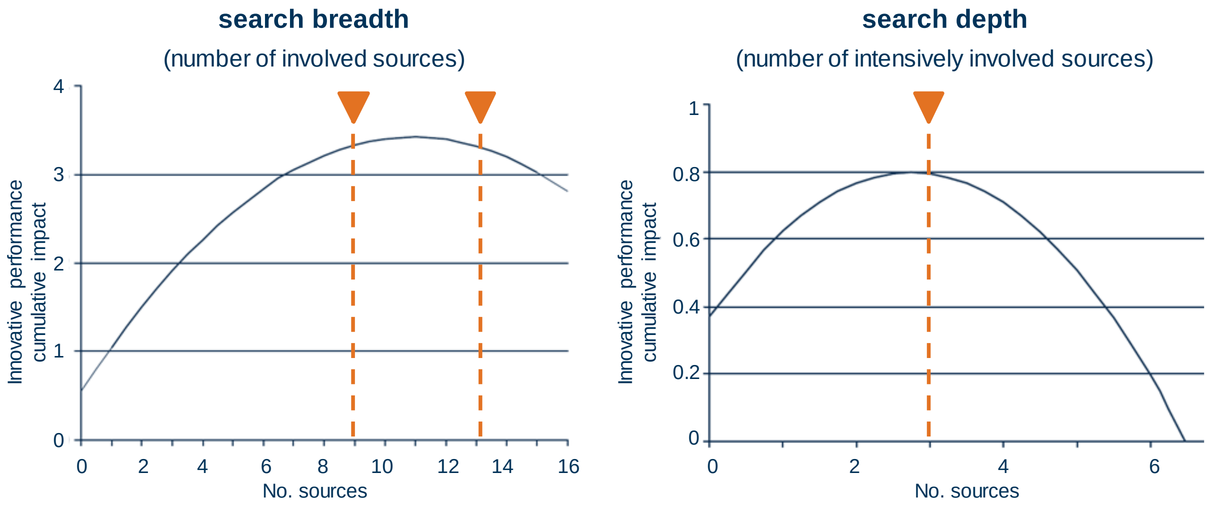

Figure 5-1: Optimal number of involved OI partners (based on: LAURSEN AND SALTER 2006, p. 143, 145)

VOLLMANN et al. (2012) empirically analyse the identification of innovative customers. Interest in a product is an indicator for a potentially high motivation, along with dissatisfaction with existing products. Memberships in specific communities can be indicators for interests and dissatisfaction themselves (VOLLMANN et al. 2012, p. 76f). Communities also allow access to knowledge of different users. Similarly, BJØRKQUIST et al. (2015) are located at the border between OI and user innovation, although they consider all stakeholders as users (BJØRKQUIST et al. 2015, p. 11). They define **four types of user involvement** and analyse their effect onto the innovation performance in health care projects: (1) ***minimal participation***: in cases where users' and company's interests are similar, (2) ***user participation***: users participate and are consulted in decision making, but the company has the final decision, (3) ***user influence***: users participate and are consulted for decision making, within given options as well as an open choice, and (4) ***user control***: users have full control and company only executes their decisions. General success factors for collaborating with customers are **incentives**, which focus on motives and interests of customers, as monetary incentives do hardly increase their motivation. OI partners also need to get the feeling that their participation contributes to a value gain (VOLLMANN et al. 2012, p. 78f).

Guidelines for identifying OI partners

Enkel et al. (2005b, p. 426) provide recommendations **what types of customers** (e.g. first buyer, reference customer) can contribute **which knowledge** elements (e.g. suggestions, complaints, prototype testing) in **different phases** of a generic product development process (from idea generation to market launch). This also includes accordingly required customer profiles for participation. In addition, they present a practically useable evaluation matrix to assess potential OI partners in terms of qualification and motivation to cooperate and innovate.

Based on the insight that identifying the place of suitable knowledge and its integration are a major challenge, Wallin and Krogh (2010, p. 148f) develop a five-step process, which supports in defining innovation process steps to develop product ideas into market-ready products. Along with the identification of relevant knowledge sources, they also address the selection of integration mechanisms and incentive strategies for OI partners. They consider different **search domains**, such as ***personnel*** (e.g. identifying teams or individual experts); ***disciplinary*** (e.g. engineering, chemistry); ***technical*** (e.g., combustion engines, imaging); ***market-based*** (e.g. segments based on gender or income class); and ***geographical*** (e.g. a country or region). Although they state all relevant steps for identifying and involving OI partners, their guideline is quite abstract and not suitable for an operational application.

An approach specifically aiming to combine the dimensions of **where** and **how to search** is the ***search path-based knowledge search*** of Lopez-Vega et al. (2016), that is therefore presented in more detail. They distinguish **four search paths**, which can be structured according to their **search space** (*local vs. distant*) and their **search heuristic** (*experimental vs. cognitive*), as shown in Figure 5-2.

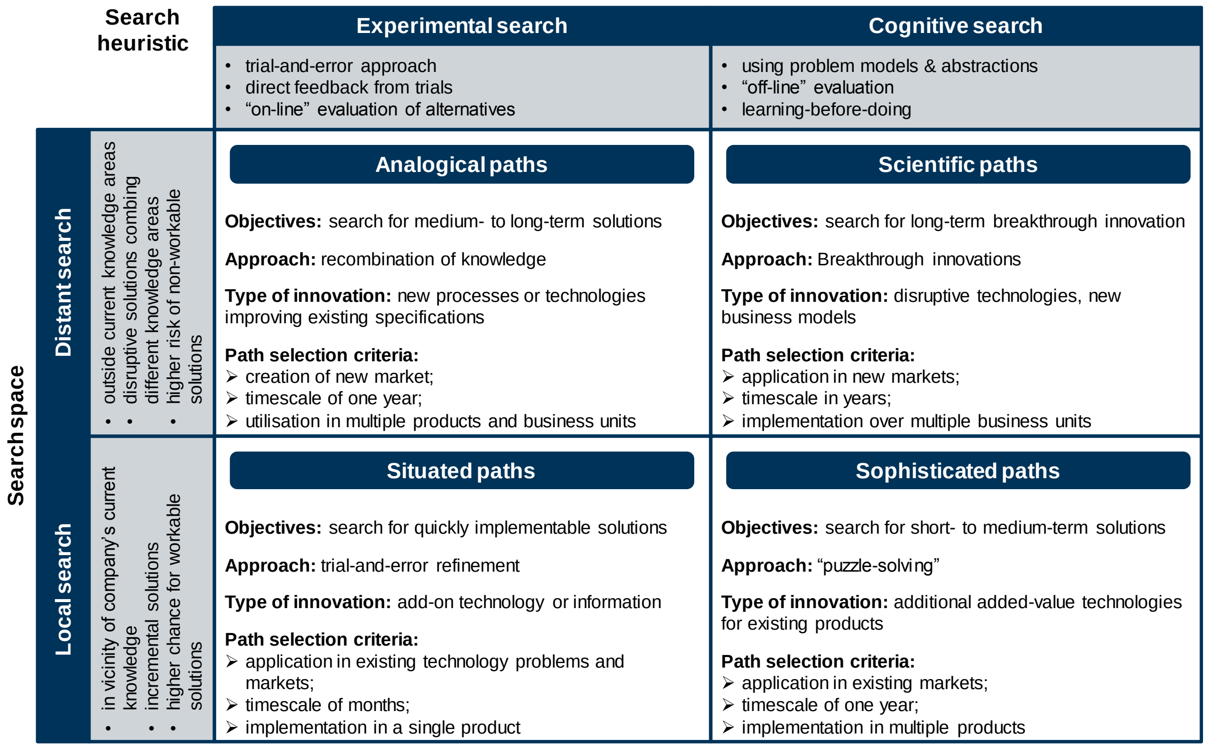

Figure 5-2: Search paths according to search space and search heuristic (Lopez-Vega et al. 2016, p. 128)

The search paths are a (1) ***situated search paths***: local trial-and-error search for incremental improvements, (2) ***analogical search paths***: experimental search in unknown disciplines allows solving current problems with new solution concepts, (3) ***sophisticated search paths***: based on predictions and hypothesis, they allow solving basic problems within known disciplines, and (4) ***scientific search paths***: exploratory and innovative research outside known disciplines allows fundamental insights for radical innovations. This framework supports in structuring and planning the OI partner search and considers the intended innovativeness and schedules. However, its primary focus is a descriptive structuring of intermediary-based OI partner searches and **lacks details of how** to specifically search within the search paths.

In respect to assessing potential OI partners, MANOTUNGVORAPUN AND GERDSRI (2015) present a three-phase **matching approach**, based on EMDEN et al. (2006). The first phase analyses the ***technological alignment*** of OI partners, i.e. their technical ability, resources and market knowledge as well as overlapping knowledge bases. The second phase assesses the ***strategic alignment*** (i.e. motivation and goal correspondence), which is followed by an evaluation of the ***relational alignment*** in the third phase (i.e. compatible cultures, propensity to change and long-term orientation). Based on this assessment, potential OI partners are *accepted* as partners, are *rejected* or classified as *pending*. The benefit of this approach is the combination of different assessment perspectives, i.e. technologic, strategic and relational, as well as a distinctive definition of assessment criteria. However, scales and measurement methods are not described. A differentiation of already known and new partners is missing as well as the consideration of dependencies between partners.

An approach for particularly searching for new OI partners and knowledge from other disciplines is **cross-industry innovation**. This industry-spanning search is challenging since the characteristics of focal and "foreign" industry differ. ECHTERHOFF (2014, p. 89f) develops a methodology which supports in analysing a problem, for instance by using **TRIZ functional modelling** (ALTSHULLER et al. 1997), and formulating it on an abstract level as a basis for the subsequent media-based search. Subsequently identified solution ideas are assessed and their adaptation is planned. Along with this approach there are alternative but principally similar cross-industry approaches, which nevertheless are usually descriptive or only abstract guidelines (BADER 2013; BRUNSWICKER AND HUTSCHEK 2010; ENKEL AND DÜRMÜLLER 2011; ENKEL AND GASSMANN 2010; FRANKE et al. 2014). Although BIANCHI et al. (2010) focus on an inside-out-perspective with their five-step **technology-push approach**, it is similar to ECHTERHOFF (2014). They also use **TRIZ functional modelling** for abstracting the features of their technology and searching for industry-spanning areas of application, including the strategic assessment and prioritisation of promising areas. The benefits of this approach are a systematic process, which uses problem abstraction to purposefully identifying relevant areas of application. However, it only focusses on identifying areas. Specific OI partners or groups of OI partners are not considered.

MEIGE AND GOLDEN (2011) develop a **big-data-based search** approach, which aims at compensating the challenges of traditional ideation platforms, such as registration effort, inactive users and not all users being experts. Their *Multistep Dynamic Expert Sourcing* approach applies web-mining technologies to identify experts, for instance, in scientific literature, patents and institute websites. This allows a dynamic and problem-specific identification and contacting of potential OI partners. However, the descriptions stay abstract.

5.3.2 User innovation related search methods

Although **user innovation** focusses on non-monetary knowledge exchange between individuals, it also comprises approaches that allow companies to benefit from the detailed and innovative knowledge of these users. In this respect, the **Lead User approach**[21] is of high relevance. Lead Users are defined as innovative users, who already show needs long before these get relevant for the majority of users (DIENER AND PILLER 2010, p. 97; HIPPEL 1986, p. 791). Since they benefit from a solution of their needs, they are highly motivated to support its development (HIPPEL 2005, p. 4). In addition, they also have the necessary expertise and skills to contribute to such a solution (DIENER AND PILLER 2010, p. 98; ERTL 2010, p. 68; VOLLMANN et al. 2012, p. 77). Lead Users can come from the own industry sector or from other industries. In particular, the latter offers the chance of radical new innovations since differing boundary conditions are likely to have caused unfamiliar solution concepts that can be adapted (HIPPEL 2005, p. 134f). Therefore, their involvement offers great benefits to a company (HIPPEL 2005, p. 127). In this respect, the identification of relevant Lead Users is crucial but also a major challenge, which have led to the development of different Lead User identification methods (DIENER AND PILLER 2010, p. 98).

Lead User identification

In general, two basic search strategies can be distinguished (GUERTLER et al. 2013, p. 4), which are in line with BOGERS AND WEST (2012, p. 68):

- **Company-based searches**: partners are identified by the company
- **Partner-based searches**: self-selection by the partners themselves via crowdsourcing methods

A search method from the first category is ***screening***. An existing group of potential Lead Users is assessed regarding up-front and project-specifically defined criteria, often by filling a questionnaire. It is particularly useful with no or only few relationships and networks between users. But the identification effort is relatively high and the efficiency limited, depending on the pool of assessed users (DIENER AND PILLER 2010, p. 99; HIPPEL 1986, p. 799; HIPPEL et al. 2009, p. 1398). An alternative search method, to overcome these shortcomings, is ***pyramiding*** (DIENER AND PILLER 2010, p. 99; HIPPEL et al. 2009, p. 1398). Starting with a small group of potential experts for a specific problem, they are asked if they know other persons, who might be even more experienced and skilled than themselves. These persons are asked the same

[21] Along with Lead Users, also other types of users gain increasing attention by academia. While Lead Users are ahead of the majority of users, "laggards" are located at the other end of the adoption curve and hesitate a long time until they buy a new product or technology. By analysing the reasons of their late adaption, they can support in improving products and bridging adaption barriers for a faster market launch. JAHANMIR AND LAGES (2015) present a seven-step "***lag-user method***" for identifying and involving laggards.

question, and so on until the pool of potential Lead Users is large enough. This is in accordance to the ***snowball technique*** of VARVASOVSZKY AND BRUGHA (2000, p. 341) and the ***effectuation search*** of SOLESVIK AND GULBRANDSEN (2013, p. 11). Pyramiding is particularly useful to identify new, hitherto unknown OI partners but requires active networks and relationships between the experts. Another search method, that uses networks of users, is ***netnography*** (BELZ AND BAUMBACH 2010, p. 305; KOZINETS 2002, p. 63f; LANGER AND BECKMAN 2005, p. 192, 200). It allows the analysis of an existing community regarding current needs, solution ideas and outstanding users. Since this observation does not require any interaction with the users, netnography is particularly useful for sensitive topics or a high need of secrecy. It also allows a comprehensive analysis of needs and solution ideas. Nevertheless, the results of the method directly depend on the quality of the community. Alternative but less frequent methods are conjoint analyses (SÄNN AND BAIER 2012) or big data searches (PAJO et al. 2015).

The second category comprises crowdsourcing methods for addressing a multitude of potential partners by an invitation for participation. While ***broadcast searches*** openly announces a problem to the public and individuals send in their solution ideas and concepts (PILLER AND IHL 2010, p. 44, 64), ***ideation contests*** announce a problem on a specific platform, where individuals post their solution ideas and concepts. This allows interactions and feedback between users (DIENER AND PILLER 2010, p. 100). Both methods ensure a specific level of motivation since the participants independently decide to submit respective post their solution ideas. Usually the gained solution ideas and concepts are only utilised to assess the expertise and skills of potential Lead Users. The actual problem is solved within a subsequent workshop.

5.3.3 Stakeholder analysis

As stakeholder analysis is a relatively new approach in the context of Open Innovation (cf. GOULD 2012) and represents a main pillar of the methodology developed in this dissertation, this chapter presents and discusses it in detail.

Stakeholders are defined as "*any **group** or **individual** who **can affect** or is **affected** by the achievement of the firm's objectives*" (FREEMAN 1984, p. 25), or more specific as all, "*who have an interest in the issue under consideration, who are affected by the issue, or who - because of their position - have or could have an active or passive influence on the decision-making and implementation processes*" (VARVASOVSZKY AND BRUGHA 2000, p. 341)[22].

Nevertheless, central characteristics can be derived: stakeholders comprise **individuals** and **groups** of individuals as well as **organisations** and groups of organisations (FREEMAN 1984, p. 25; KARLSEN 2002, p. 20; MITCHELL et al. 1997, p. 855), which can be **internal** within the same organisation, organisational-**external** or within the same network (BALLEJOS AND MONTAGNA 2008, p. 284; KARLSEN 2002, p. 20; SHARP et al. 1999, p. 389). Along with stakeholders of a company, there can also be specific stakeholders of a project (KARLSEN 2002, p. 20). Stakeholders can either play an **active** and influencing, or **passive** and influenced role (FREEMAN 1984, p. 25; KARLSEN 2002, p. 20; MITCHELL et al. 1997, p. 859; SHARP et al. 1999,

[22] Over the years, several authors seized and slightly adapted the definition and its focus. An overview of different definitions is provided, for instance, by MITCHELL et al. (1997, p. 858) and HABICHT (2009, p. 18f).

p. 387). VOS AND ACHTERKAMP (2004, p. 9) also stress the relevance of passive stakeholders since they can get active stakeholders acting in their interests. This interest itself can be differentiated into positive, supporting and negative, refusing interest (MACARTHUR 1997, p. 253). KARLSEN (2002, p. 20) and MITCHELL et al. (1997, p. 859) further distinguish current and potential stakeholders, and **primary and secondary stakeholders** in respect to the relevance of involving them. Although a study in Norway indicate that customers and end users are the most important stakeholders (KARLSEN 2002, p. 19), there is a multitude of different stakeholders, as illustrated in Figure 5-3.

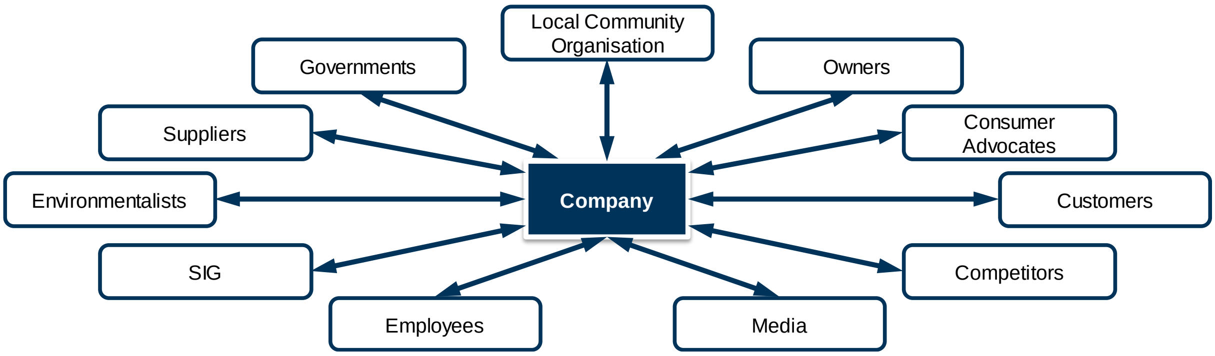

Figure 5-3: Exemplary stakeholders (FREEMAN 1984, p. 25, 55; KARLSEN 2002, p. 19)

Stakeholders are crucial for the success of a project since they **can support** in solving problems, evaluating future trends, facilitating trust and improving a company's public image as potentially influential partners. However, they **can also cause problems** and risk the success of a project (KARLSEN 2002, p. 19f; SMITH et al. 2011, p. 6).

Purpose of a stakeholder analysis

VARVASOVSZKY AND BRUGHA (2000, p. 338) define a stakeholder analysis (SHA) as "*an approach, a tool or set of **tools for generating knowledge about actors** - **individuals and organizations** - so as to understand their **behaviour, intentions, interrelations and interests**; and for **assessing the influence and resources** they bring to bear on decision-making or implementation processes.*". Hence, SHA supports in planning a project, frequent evaluation of involved partners and an improved understanding of stakeholders, their different needs, interests and relationships to each other (KARLSEN 2002, p. 23; MACARTHUR 1997, p. 251; VRIES et al. 2003, p. 105). It identifies potential project partners and relevant influencers as well as risks and threats for the project (BLAIR et al. 1996, p. 9; BRYSON 2004, p. 29; VARVASOVSZKY AND BRUGHA 2000, p. 339; VOS AND ACHTERKAMP 2004, p. 6). Therefore, SHA is the basis for stakeholder and project management by defining which stakeholders are involved at what time and in which way (BRYSON 2004, p. 27; KARLSEN 2002, p. 23).

To support the identification, analysis and involvement of stakeholders, different approaches have been developed, which have differing perspectives and focusses (cf. GUERTLER et al. 2013). Common research perspectives are **management issues** (LEWIS et al. 2007; MOSTASHARI 2005; VOS AND ACHTERKAMP 2004), **governmental policy making** (VARVASOVSZKY AND BRUGHA 2000), **company policy making** (BLAIR et al. 1996; BRYSON 2004; SAVAGE et al. 1991; SMITH et al. 2011), **project planning** (BALLEJOS AND MONTAGNA

2008; MacArthur 1997; Mitchell et al. 1997; Vries et al. 2003) and **product development** with focus on requirement engineering (Bunn et al. 2002; Elias et al. 2002; Sharp et al. 1999; Vos and Achterkamp 2004; 2006), as well as some **superordinate concepts** (AccountAbility AA1000; Freeman 1984; 2010; Karlsen 2002). In addition, Gould (2012) and Kirschner (2012, p. 49f) consider stakeholder analysis from the **perspective of OI** and an open product development. Nevertheless, a detailed analysis of activities within different SHA approaches revealed a basically similar process structure (Guertler et al. 2013; Guertler et al. 2014c)[23], as shown in Table 5-3 and in line with Karlsen (2002, p. 23):

Table 5-3: Phases of stakeholder analysis (Guertler et al. 2013; Guertler et al. 2014c)

Phase	Description
Planning / Preparation	planning the stakeholder analysis and defining the purpose, process organisation, time, resources, frequency, documentation
Identification	systematic identification of current and potential stakeholders
Analysis	assessment of stakeholder characteristics and analysis of relationships
Prioritisation and selection	derivation of most relevant stakeholders
Development of cooperation strategy	developing involvement strategies and start of cooperation
Involvement and controlling	controlling of stakeholder involvement and evaluation of stakeholder dynamics

A sufficient planning of the stakeholder analysis is crucial for its success. It is necessary to define the project’s goal, and understand differing contexts and cultures of companies and countries to allow a purposeful identification and assessment of stakeholders (Bryson 2004, p. 27; Karlsen 2002, p. 23; Varvasovszky and Brugha 2000, p. 340; Vos and Achterkamp 2004, p. 13)

Stakeholder identification

Along with **expert interviews** and **checklists** (Karlsen 2002, p. 23), the most common method for stakeholder identification is **brainstorming** by individuals and groups (Bryson 2004, p. 28; Karlsen 2002, p. 23; Vos and Achterkamp 2004, p. 13f). However, brainstorming has the major shortcomings of being unstructured and having a high risk of missing stakeholders (Vos and Achterkamp 2004, p. 3) – especially since stakeholders over the entire product life cycle have to be considered (Sharp et al. 1999, p. 389).

For a more structured search, Varvasovszky and Brugha (2000, p. 339) propose different **search dimensions**, such as purpose of the project, time frame, scope of search and project stage. Ballejos and Montagna (2008, p. 285) use a **search matrix**, which also combines “*selection dimensions*” (i.e. company-internal, network-internal, external) with “*selection criteria*” (i.e. function, geographical location, hierarchical level, and knowledge and abilities). While the **guiding questions** of Vos and Achterkamp (2004, p. 15) focus on identifying clients, decision makers, designers and passively involved stakeholders, Vries et al. (2003,

[23] A detailed graphical analysis and comparison of different stakeholder analysis approaches and process elements can be found in Guertler et al. (2013).

p. 98f) present **nine search directions** for a comprehensive identification, such as along the production chain, designers, regulators and education. Related to the previous production chain perspective, KAIN et al. (2009) develop a search approach based on the **value creation process**. An alternative, open approach is the **snowball technique** of VARVASOVSZKY AND BRUGHA (2000, p. 341), which works similarly to the pyramiding method from the Lead User identification (HIPPEL et al. 2009).

Stakeholder Analysis

Since the stakeholder identification normally results in a large list of individuals and organisations that cannot all be involved in a project, it is essential to assess them and derive the most important ones (SMITH et al. 2011, p. 12; VRIES et al. 2003, p. 100). Information for the assessment can be come from primary sources like directly asking stakeholders, and secondary sources like documents and reports (VARVASOVSZKY AND BRUGHA 2000, p. 341). While MITCHELL et al. (1997) only consider a binary scale (*applies, does not apply*) for their stakeholder assessment criteria (*power, legitimacy, urgency*), usually more detailed scales are used, like a three-step scale (*low, medium, high*) (e.g. VARVASOVSZKY AND BRUGHA 2000, p. 342). Although MITCHELL et al. already presented their criteria in 1997, the majority of stakeholder analyses are based on the following three criteria:

- ***Power*** (MITCHELL et al. 1997, p. 865), also called *influence* (VARVASOVSZKY AND BRUGHA 2000, p. 342) or *control* (ULRICH 1989, p. 83):

  It describes that a stakeholder can act against the will of other stakeholders or make them act in his interests. He has access to support mechanisms, votes or sanction mechanisms (BRYSON 2004, p. 34).

- ***Legitimacy*** (MITCHELL et al. 1997, p. 866; ULRICH 1989, p. 83)

  It indicates if a stakeholder is entitled to claim his interests, for instance, due to his social, hierarchical or organisational position.

- ***Urgency*** (MITCHELL et al. 1997, p. 867)

  It states how time-critical the claims of a stakeholder are.

In addition, ULRICH (1989, p. 83) and VARVASOVSZKY AND BRUGHA (2000, p. 342) propose to analyse the stakeholders' **motivation or interests** since they directly affect the claims of stakeholders. Based on the impact of the issue on a stakeholder, his **attitude or position** (i.e. supportive, neutral, opposed) towards the project can be analysed (VARVASOVSZKY AND BRUGHA 2000, p. 342). Along with this, KARLSEN (2002, p. 23) assesses the **potential for threatening or affecting the project** (i.e. power) and **potential for collaboration with the project**. ULRICH (1989, p. 83) also mention operative technical criteria, such as design skills and knowhow, but have not been followed up on.

General challenges in assessing stakeholder criteria are the knowledge and abilities of the assessing persons and the dynamics of criteria (MITCHELL et al. 1997, p. 868). This, along with other assessment biases and active misleading of stakeholders, can lead to suboptimal or critical involvement strategies (BLAIR et al. 1996, p. 10). To therefore support SHA teams, BRYSON (2004, p. 29f) presents different methods, such as the ***basic stakeholder analysis technique*** that helps to identify the motives and power of stakeholders, the ***stakeholder-issue interrelationship***

diagram that graphically identifies stakeholder interests and interdependencies, the ***power versus interest grid*** that ranks stakeholders regarding their project relevance, and ***problem-frame Stakeholder map*** that differentiates stakeholders in supporters and opponents, grouped according to their power.

Stakeholder Involvement

Closely linked to the selection of relevant stakeholders is the derivation of **appropriate involvement strategies**, such as *collaborating*, *monitoring* or *defending* them (Savage et al. 1991, p. 65f). In general, stakeholders can be clustered in **active stakeholders**, who somehow contribute to a project, and **passive ones**, who are affected by the outcome (Vos and Achterkamp 2004, p. 7f). Blair et al. (1996, p. 10) and Savage et al. (1991, p. 65f) distinguish four fitting situations of stakeholders and involvement strategies, as depicted in Figure 5-6: an optimal fit, a suboptimal fit due to a defensive involvement and missed chances, a suboptimal fit due to involving useless stakeholders and wasted resources, and a critical fit that can endanger the project and even the company. Therefore, different methods exist, which support in deriving the most relevant stakeholders and fitting involvement strategies.

Mitchell et al. (1997, p. 873f) use their three stakeholder criteria to derive **three stakeholder groups**, which can be subdivided into **eight classes**, as shown in Figure 5-4. Stakeholder that fulfil no criterion are *non-stakeholders* (SH) and can be neglected. *Latent stakeholders* fulfil one criterion, *expectant stakeholders* two criteria and *definite stakeholders* all three criteria.

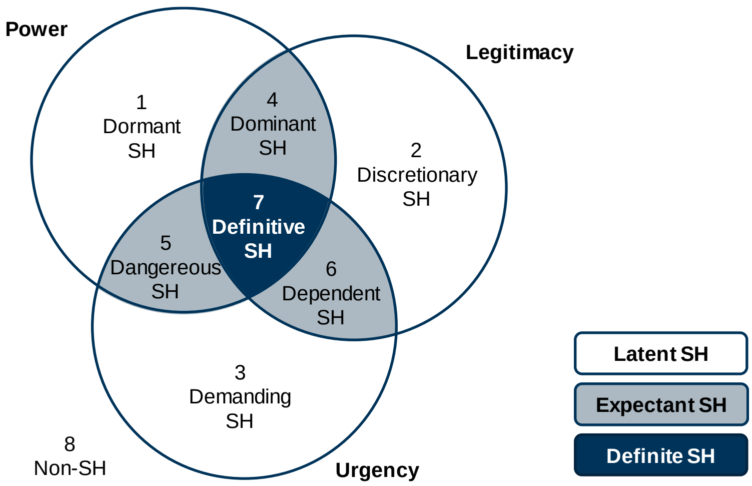

Figure 5-4: SH classes based on their power, legitimacy and urgency (Mitchell et al. 1997, p. 874)

Latent stakeholders can primarily be ignored. Nevertheless, due to potential dynamic changes of criteria, they should be evaluated regularly. **Expectant stakeholders** need a more detailed consideration: *dominant stakeholders* should receive high attention die to their power and legitimacy to use it, *dangerous stakeholders* should be identified but not accepted due to their power and urgency but missing legitimacy, and *dependent stakeholders* should be monitored and their claims considered since they might try to mobilise powerful stakeholders for their urgent and legitimate claims. **Definite stakeholders** have the highest priority and should always be considered.

While MITCHELL et al. (1997) primarily focus on the question if stakeholders' claims need to be considered, BRYSON (2004, p. 32) specifically address the involvement of stakeholders by his ***participation planning matrix***. It combines different activity categories (e.g. project management, creating ideas) on the y-axis, and different levels of participation on the x-axis. The latter can be differentiated in: ***inform*** (providing information of project's progress), ***consult*** (informing and considering their feedback), ***involve*** (light, irregular involvement in meetings), ***collaborate*** (regular involvement in meetings), and ***empower*** (involvement as decision maker). By assigning stakeholders to different matrix/table[24] cells, their specific contribution and time of involvement can be planned. However, this method does not support the actual assigning process. MACARTHUR (1997, p. 255) presents a similar matrix, which uses generic project phases instead of activities but similar involvement strategies: ***inform, consult, partnership, delegate*** and ***control***. VOS AND ACHTERKAMP (2004, p. 14) also assign stakeholders to different project phases (*initiation, development, implementation, maintenance*) but only define a rough level of involvement (*for certain, possibly, should not*), which they combine with different project roles.

The use of **project roles** is a different approach for deriving relevant stakeholders as well as reducing the risk of missing important stakeholders. These roles represent activity profiles, which need to be fulfilled or assigned to stakeholders to ensure the success of a project. In this respect, one stakeholder can have one or more project roles, and vice versa. Stakeholders with no assigned project role should be evaluated if they can be neglected. All project roles should have at least one assigned stakeholder. While SHARP et al. (1999, p. 389) states relative rough project roles of requirement engineering, so called *baseline stakeholders* (i.e. users, developers, legislators, decision makers), as well as VOS AND ACHTERKAMP (2004, p. 10) with three active innovation project roles (client, decision maker, designer) and one passive role (representative for other stakeholders), BALLEJOS AND MONTAGNA (2008, p. 285) present a large pool of diversified roles of inter-organisational software development projects. These roles need to be adapted and enhanced according to the specific project situation. In general, project roles and the previous involvement strategies have a large overlap, as for instance, the RACI roles (*responsible, accountable, consult, inform*) of project management show (PMI 2013, p. 262). The majority of project roles imply a specific involvement strategy, for instance, the role of a decision maker. Table 7-11 provides an overview of different project roles.

FREEMAN (1984, p. 132, 141f) uses **portfolios** to provides support in methodically assigning stakeholders to different involvement strategies. They are assessed regarding their *relative cooperation potential* (expected changes to more supportive behaviour) and their *relative competitive threat* (potential risks and actions of stakeholders to harm the company), and positioned in a portfolio accordingly, as depicted in Figure 5-5 on the left side. Based on the position in the portfolio, four different types of stakeholders and generic involvement strategies can be derived: (1) ***swing stakeholders*** with a *change-the-rules strategy* of interaction, due to their high potential influence, (2) ***defensive stakeholders*** with a *defensive strategy* of a restrained involvement, due to little support and threat potential, (3) ***offensive stakeholders*** with an *exploit strategy* of involvement, due to high support potential but high risk if they are

[24] Actually a table, but the differentiation between matrices and tables is not considered by BRYSON (2004).

not considered, and (4) ***hold stakeholders*** with a *hold strategy* of no involvement but observation due to potential changes of their behaviour.

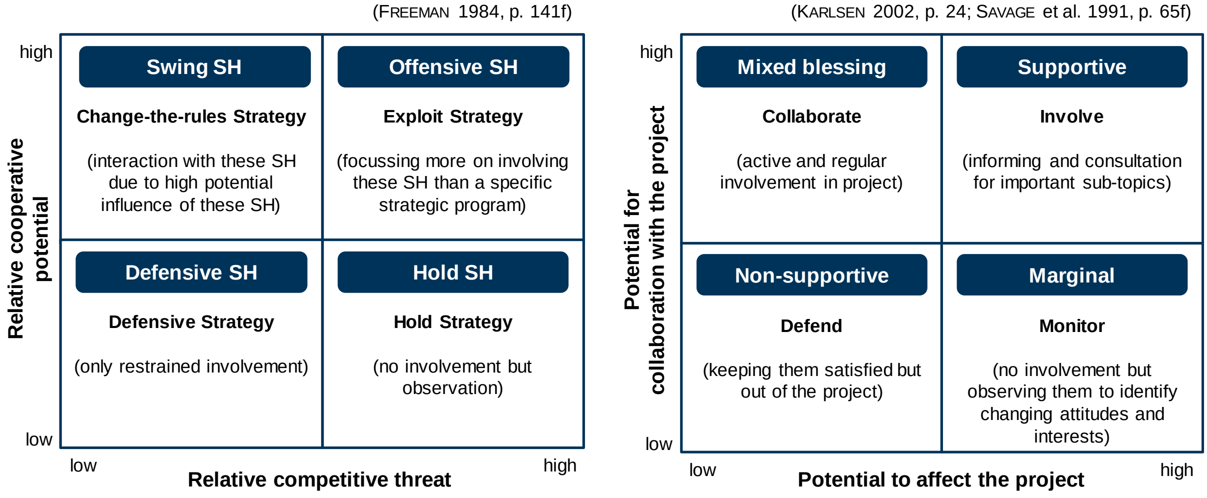

Figure 5-5: Stakeholder involvement strategies: left side (FREEMAN 1984, p. 141f), right side (KARLSEN 2002, p. 24; SAVAGE et al. 1991, p. 65f)

KARLSEN (2002, p. 23f) presents a similar approach based on SAVAGE et al. (1991, p. 65f). Stakeholders are assessed regarding their *potential for collaboration with the project* and their *potential to affect the project*. Except the specific wording, the criteria as well as the resulting types of stakeholders and involvement strategies correlates with the portfolio of FREEMAN (1984), as illustrated in Figure 5-5 on the right side.

To ensure the success of the project and to allow the traceability of decisions and future adaptations, the **documentation** of the results of the stakeholder analysis are crucial. BALLEJOS AND MONTAGNA (2008, p. 287) suggest *stakeholder profiles*, which comprise all relevant information about stakeholders, and are in line with the *policy implementation strategy development grid* of BRYSON (2004, p. 45). Both tools help to manage the dynamics of stakeholders as a major challenge of stakeholder analysis (KAIN et al. 2009, p. 194; MITCHELL et al. 1997, p. 879; VOS AND ACHTERKAMP 2004, p. 5). The appearance or disappearance of stakeholders and relationships as well as changes of stakeholder criteria can cause missed opportunities when new relevant stakeholders are not involved, wasted resources when stakeholders lose their relevance, and project risks when new critical stakeholders are not identified and considered.

For the subsequent **acquisition of project partners**, VARVASOVSZKY AND BRUGHA (2000, p. 341) propose two strategies: (1) **using a powerful stakeholder** to ask other stakeholders can increase their motivation due to his influence but it can also cause response biases. (2) **independent research institutes** can serve as neutral actors and avoid response biases but they might be considered as irrelevant by the specific stakeholders.

Stakeholder-Analysis-Team

To compensate assessment biases of individuals, a team-based assessment is important since it supports the reflection and discussion of assumptions (VARVASOVSZKY AND BRUGHA 2000,

p. 340). In particular interdisciplinary teams can benefit by different backgrounds, knowledge and approaches (Karlsen 2002, p. 23). To avoid team-specific biases, team-external actors can also be involved (Varvasovszky and Brugha 2000, p. 340).

Intermediate conclusion of stakeholder analysis in the context of OI

Gould (2012, p. 7) state the general benefit of stakeholder analysis (SHA) for OI but does not provide further information about how to enable these benefits in detail. The general strengths of SHA are its **strategic management perspective** for ensuring a project's success and the consideration of networks and relationships between different actors. The latter are particularly relevant for SMEs due to their location within different company networks (cf. chapter 2.4.3). However, similar to OI, a successful SHA requires a systematic identification process (Vries et al. 2003, p. 104). Usually stakeholders are identified by variations of brainstorming, which is not structured enough and bears a great risk of incompleteness (Vos and Achterkamp 2004, p. 3). Along with the identification of stakeholders, the choice of the appropriate involvement strategy is essential for the success of a project. Based on the types of stakeholders and involvement strategies of Savage et al. (1991, p. 65f), Blair et al. (1996, p. 11) and Varvasovszky and Brugha (2000, p. 344) analysed the effects of selecting an insufficient strategy. As illustrated in Figure 5-6, a too restrained involvement strategy is suboptimal due to missed opportunities, while involving marginal stakeholders is suboptimal due to a waste of resources and bad cost-benefit ratio. In the worst case, the involvement of negative stakeholders can even risk the success of the project and the company. Methodical support is often quite rudimentary and not sufficient for an application in industry (cf. Ballejos and Montagna 2008, p. 284; Bryson 2004, p. 27). In general, SHA is a powerful approach but needs to be adapted to the specific application contexts (Kain et al. 2009, p. 197).

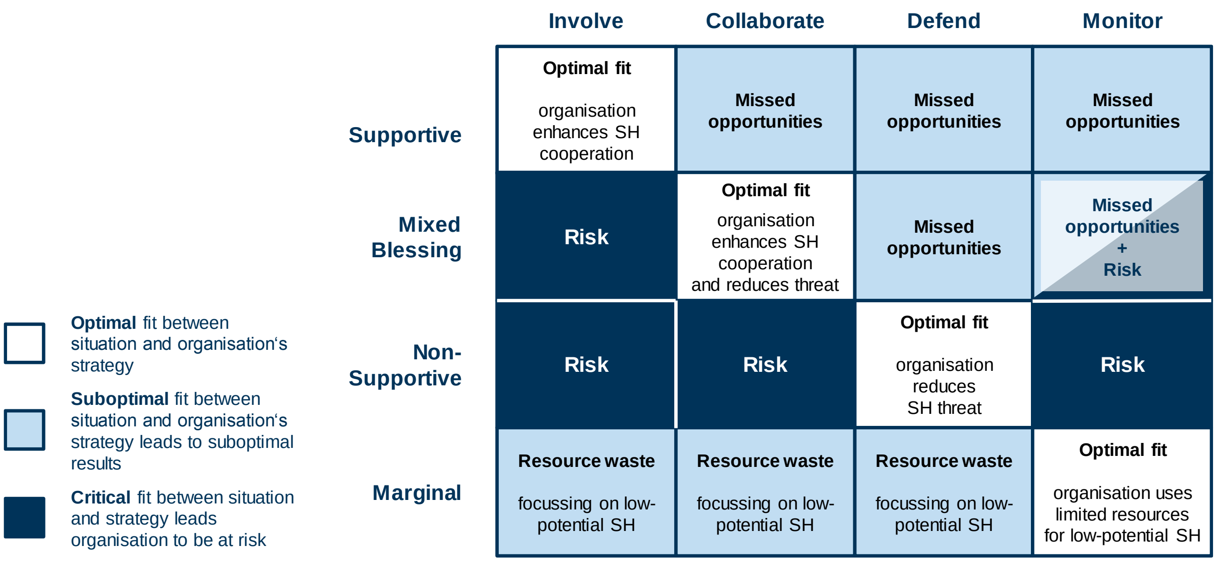

Figure 5-6: Disadvantages resulting from an insufficient SH involvement strategy (Blair et al. 1996, p. 11)

5.3.4 Approaches from other disciplines

Along with the previous major approaches, a variety of other partner search methods from different disciplines exist. These can be used to enhance the previously presented search methods. For a systematic identification of such alternative search methods, a generic product life cycle used as a basis. For each phase typical partners were identified. These themselves served as basis to identify specific search methods for them: for instance, search methods to identify suppliers within the production phase. In total, 39 search methods could be identified (cf. PE: VERGES 2015). They can be clustered into the following groups (cf. GUERTLER AND LINDEMANN 2016a, p. 5), as shown in Table 5-4.

Table 5-4: Groups of different search methods

Type of search	**Description**
Pool-based search	It takes place within a specific pool or group of potential partners, e.g. *screening* (HIPPEL et al. 2009), *innovative capacity-based screening* (MATTHING et al. 2006), *co-branding partner search* (NEWMEYER et al. 2014) and within online communities by means of *netnography* (BELZ AND BAUMBACH 2010; LANGER AND BECKMAN 2005)
Database search	It is located within specific databases, e.g. supplier databases or patent databases (BYUNGUN YOON AND BOMI SONG 2014; JEON et al. 2011; YAMADA et al. 2013)
Network-based search	It uses existing company networks or relationships between potential actors to identify suitable project partners, e.g. *pyramiding* (HIPPEL et al. 2009)
Algorithm-based search	It applies optimisation models and algorithms to derive suitable partners (BÜYÜKÖZKAN et al. 2008; SU et al. 2015), as well as big data analyses (MEIGE AND GOLDEN 2011; PAJO et al. 2015)
Open search	It is independent from specific groups or networks and supports the identification of completely new partners, e.g. a *cross-industry search* (CHEN 2014; ECHTERHOFF 2014; LI et al. 2008)
Open call search	In contrast to the other search methods that are actively executed by a company, in this case, a company publishes a call for participation. It is followed by a self-selection of potential partners, e.g. *broadcast search* or *marketplaces* (DIENER AND PILLER 2010; NGUYEN et al. 2014; PILLER AND REICHWALD 2009)

The overview shows a large overlap with search methods from OI, Lead User identification and stakeholder analysis since these are established approaches for identifying relevant project partners. The other search methods usually use specific databases and algorithms to identify potential partners. Due to their specificity and complexity, they are not further considered within this dissertation. Nevertheless, some of these methods might be beneficial for specific OI projects and should be considered more closely in the future.

5.3.5 Evaluative summary of existing partner selection approaches

The previous analysis of the state of the art of partner search approaches revealed promising partial approaches but a lack of a sufficient holistic one. **OI-specific approaches** have a primarily external focus while widely neglecting potential internal OI partners. The latter are only marginally considered by methods like internal ideation contests. OI-specific approaches allow the identification of OI partners from a pool of actors, who are already known to the company, as well as completely new OI partners by methodologies like cross-industry searches. Criteria for search and selection focus on operative technical skills and expertise of OI partners. Strategic characteristics of and relationships among OI partners are hardly considered.

User innovation approaches are quite similar to OI-specific approaches due to a common basis of working principles, i.e. the knowledge exchange with and between different external actors. In contrast to OI-specific approaches, user innovation approaches, in particular **Lead User identification**, are less abstract and better operationally useable. Despite its historical origin in the field of user innovation, in practice, it is difficult to assign Lead User identification exclusively to user innovation since it is frequently applied for OI as well. Nevertheless, Lead User identification is considered an independent approach in the following. It focusses on the identification of external OI partners with specific operational skills and expertise, only marginally considers internal OI partners and neglects a strategic perspective. Networks and dependencies between actors are only implicitly considered by search methods like pyramiding, which require relationships between actors to identify potential OI partners.

In contrary, **stakeholder analysis** allows a holistic evaluation of internal and external actors due to its focus on ensuring the success of a project by identifying all actors influencing or being influenced by the project. Therefore, it has a strong strategic perspective and assesses all factors that might influence the performance and success of a project, such as interests and power of actors as well as dependencies between actors, which might cause primarily unforeseen behaviours of actors. An operative perspective is only addressed by a minority of authors. But even there, it only has a subordinate role. In addition, except some identification methods like snowball search, stakeholder analysis focusses on known actors and do not aim at identifying new, hitherto unknown actors.

The **alternative search methods** show a great heterogeneity but also tend to focus on external partner with specific operative skills and competences. They can be useful to enhance an integrated partner search methodology by specific search methods depending on the particular context and goal of the project.

In summary, OI-specific search approaches and Lead User identification, with their focus on identifying suitable known or new OI partners with specific operative skills and expertise, are complementary to stakeholder analysis, which aims at ensuring the strategic success of a project by considering interests, potential behaviours and dependencies between known actors. Therefore, a combination of the strengths of these approaches in the context of an integrated OI partner search methodology bears great advantages, as indicated by GOULD (2012, p. 7). Table 5-5 summarises the results of the requirement analysis.

Table 5-5: Requirement analysis of existing partner selection approaches

Selection of OI partners	**OI-specific approaches**	**Lead User identification**	**Stakeholder analysis**	**Alternative search methods**
Consideration of external stakeholders	●	●	●	●
Consideration of internal stakeholders	◑	◑	●	◑
Supporting the identification of OI partners from a known pool of actors	●	●	●	●
Supporting the identification of unknown new potential OI partners	●	●	◔	●
Consideration of an operative technical perspective	●	●	◔	●
Consideration of a strategic perspective	○	○	●	○
Consideration of stakeholder dependencies and networks	○	◔	●	◕

5.4 Approaches for selecting suitable Open Innovation methods

Although SMEs need to know and apply different methods to support their innovation management, they are also usually overwhelmed by the large number of potential methods (MEYER 2005, p. 292f). In general, they have only limited experience with the utilisation of methodical support (MEYER 2013, p. 230). Therefore, it is important to provide them sufficient help in selecting methods, which fit to the situation and actors (cf. LINDEMANN 2009, p. 59). This chapter presents establishes approaches for structuring and selecting methods, based on a first literature analysis in GUERTLER et al. (2015a).

5.4.1 Method models

The basis of a systematic selection of methods is a sufficient characterisation, which describes the specific features, advantages and disadvantages in a standardised way and allows a comparison of different methods[25]. This is the basis of method model kits, which comprise a structured pool of methods and support the selection of suitable ones (EHRLENSPIEL AND MEERKAMM 2013, p. 359f; NAEFE 2012, p. 48f).

General method models

An established approach is the use of ***method models*** or ***method profiles***. In literature, different method models can be found, which varies in terms of focus, particular characteristics or

[25] A detailed analysis of method models and method kits is presented by HUTTERER (2005, p. 22f) and PONN (2007, p. 92f).

wording but have the same principal structure. For instance, the ***Munich Method Model (MMM)*** focusses on the goal and purpose of the methods, including necessary inputs and intended outputs as well as boundary conditions. To support the understanding of the specific methods and to point out aspects for adaptations, the MMM also describes the process steps within the methods (LINDEMANN 2009, p. 59f). The ***Process oriented Method Model (PoMM)*** of BIRKHOFER et al. (2002, p. 18f) shows an even stronger process focus. Along with *process modules*, which describe the actual method and correlate with the MMM (e.g. inputs, outputs, process sequence), the PoMM also has *access modules*, which comprise superordinate characteristics that support the identification and selection of methods, such as keywords and relationships to other methods. MMM and PoMM are illustrated in appendix 13.2.3.

An alternative method model is presented by PONN (2007, p. 126f), which is based on the previous models but is structured in three main sections: (1) **method profiles**, which describe the features of a method and allow a quick selection of methods, (2) **context factors**, which describe requirements of boundary conditions to apply the methods, and (3) **execution details**, which describes the inherent process steps, necessary tools and links to other methods. In contrast to the other two models, he also links methods via specific characteristics to project situations and tasks. To support the adaption of methods to the specific boundary conditions, ZANKER (1999, p. 56f) distinguishes *basic activities*, which represent the unalterable core of a method, and *characteristics* of method and boundary condition, which allow the derivation of required adaptations.

In summary, the presented method models lack an OI perspective and only support a discursive selection of methods. The models show large similarities. The MMM offers a systematic description of methods but is too detailed for a use in a SME’s context. It also does not consider actors. The PoMM considers actors as users of the method, along with a systematic characterisation of methods. However, also the PoMM is quite extensive. PONN (2007) presents a combination of method model and method model kit by linking methods to specific situations and tasks. He only indirectly considers actors via requirements of the method profiles. The approach of ZANKER (1999) allow a clear distinction of core elements and adaptable aspects of a method, which supports in identifying and executing necessary adaptations.

OI-specific method model

Based on the analysis of other method models, KIRSCHNER (2012, p. 92) presents a method model, which focusses on OI methods in the context of open product development, such as Lead User workshops, communities and toolkits. It comprises 23 characteristics, which can be clustered in **user characteristics** (e.g. position in value chain), **type of involvement** (e.g. directness of contact,), **type of knowledge exchange** (e.g. type of knowledge), **time of involvement** (e.g. time in innovation process) and **goal of knowledge exchange** (e.g. type of innovation). In addition, he states the lack of distinctive specifications of method characteristics in literature (KIRSCHNER 2012, p. 90).

Although they are not explicitly clustered, the advantages of this OI method model is the consideration of different categories of characteristics, such as OI partners, type of involvement and goal of the knowledge exchange. However, this approach primarily focusses on open product development but not on OI in general. Therefore, it is only useable with limitations for

OI. The specification scales for the characteristics are not explicitly stated and can only implicitly derived from a depicted table. Along with this, the comprised OI methods show a varying level of abstraction: while toolkit and ideation contest are specific methods, crowdsourcing and mass customisation are superordinate concepts, which comprise single methods like the previous ones. Thus, both types of presented "methods" are not comparable. In addition, the method model does not consider a holistic OI situation and experience with OI.

5.4.2 Decision trees

An alternative approach for selecting methods is a **decision tree** (SAFAVIAN AND LANDGREBE 1990), which is an established approach for decision making in different disciplines. Its basis is the definition of distinguishing characteristics, which can, for instance, be derived from a method model. They are ranked according to their relevance in the application context, e.g. the amount of possible collaboration partners. The most relevant selection criterion builds the trunk of the tree, and its specifications span the first level of branches. Each branch comprises the selection criterion of the next level, and their specifications span further branches. Suitable methods of each criteria chain are located in leaves of the branches.

5.4.3 Portfolio-based selection

Method portfolios allow a graphical selection of suitable methods. These are structured according to two central distinguishing criteria, for instance for OI methods, task decomposition and distribution of problem solving knowledge (LAKHANI et al. 2013, p. 355), or the direction of knowledge flow and financial flows (CHESBROUGH AND BRUNSWICKER 2013, p. 10). Suitable methods can be identified based on their position in the portfolio.

5.4.4 Software-based method selection tools

Software-based selection tools use method profiles and enhance them by a graphical user interface, where a user can enter the project-specific specifications for predefined selection criteria. These are linked to the characteristics of the method profiles. Depending on the specific tool, unsuitable can be just filtered or methods can be ranked according to their suitability.

WiPro

An exemplary web-based selection tool is **WIPRO 2010** (www.innovationsmethoden.info) of the Technology and Innovation Management Group at RWTH Aachen University. It comprises 115 methods, including four OI methods[26], which are structured based on a rudimentary method model of seven characteristics, such as activity to support, size of company and complexity.

The advantage of the web-based WiPro platform is its intuitive use and accessibility from all over the world. The disadvantages are the low number of only four OI methods and a missing ranking of potentially suitable methods. The set of characteristics does not allow a detailed

[26] State: 15.01.2015

characterisation of OI methods. While the project situation is roughly considered, a matching with collaboration partners is missing. Another shortcoming is the missing ranking of methods as the filtering might exclude principally suitable methods.

Methodos

A similar web-based selection tool is **Methodos** (BAVENDIEK et al. 2016). It also uses a set of selection criteria to filter suitable product development methods. It focusses on teaching students in the context of a specific lecture. Therefore, it comprises detailed information of each method including visualisations and short video tutorials. So far, it is only accessible for registered students. In line with WiPro, it has the shortcoming of using a filtering mechanism instead of ranking and showing all potential methods.

InnoFox

A more sophisticated tool is the app-based **InnoFox**, which comprises more than 100 methods for product development, knowledge management and future management (ALBERS et al. 2014a; ALBERS et al. 2015a; REIß et al. 2016). These methods are documented and stored by a method model, which is based on other models like BIRKHOFER et al. (2002). It comprises characteristics, such as a short description, advantages and disadvantages, inputs and outputs, central process steps, supporting tools and alternative methods. The app itself is based on **iPeM** (cf. chapter 2.2.4), which links a vague system of objectives to a specific system of objects. The objectives are predefined and range from a reduction from development time and costs to learning effects of involved actors. The user can also select from 70 intended activity fields in the DMM of activities of product engineering and activities of problem solving. Subsequently, the user defines the limiting system of resources, for instance, the number of necessary users, type of necessary infrastructure and time for executing the method. The interactive app dynamically filters and ranks the methods in the pool according to the user's input. The ranking itself is based on a set of formulas, which are explained in detail by ALBERS et al. (2015a, p. 7).

The benefits of InnoFox are its graphical and intuitive user guidance. The user can define the application context in detail by different selection criteria by choosing from distinctive criteria specifications. In addition, the app also offers a simplified interface for inexperienced users along with an expert mode. Suitable methods are ranked according to their suitability score and also mapped to SPALTEN steps, where they are most useful. The disadvantages are a missing consideration of OI methods, and a holistic consideration of internal and external boundary conditions. The ranking formula is relatively complex and requires according trust in its correctness by the user. Since the app is a closed system, users cannot check the formula and its parameters, or autonomously enhance it by further methods.

5.4.5 Scoring-based selection approaches

These approaches combine method models and a simplified version of a DMMs for ranking methods according to their suitability score for a specific situation. Selection criteria and methods are directly linked. ROTHE et al. (2014) present an OI-specific scoring-based selection approach. Its core element is a simplified DMM, which maps the selection criteria (i.e. characteristics from the method model) to each method, as shown in Figure 5-7.

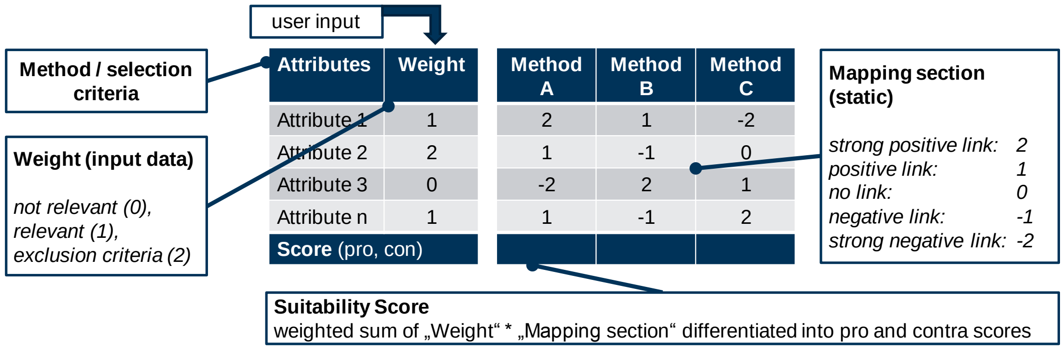

Figure 5-7: Structure of a scoring approach (GUERTLER et al. 2015a, p. 7; based on: ROTHE et al. 2014)

The regarding scale ranges from "-2", a strong contra indicator, to "+2", a strong indicator for this specific method. In total, 15 criteria are considered, which can be clustered in four groups: **company-specific criteria** (e.g. *existing infrastructure, absorptive capacity and existing collaborations*), **innovation-specific criteria** (e.g. *maturity level of innovation and type of innovation*), **innovation process phases** (e.g. *ideation phase and concept development phase*), and global **criteria of exclusion** (cf. appendix 13.2.4). The user input is realised by **weighting each selection criterion**: "0" when irrelevant for this case, "1" when relevant, and "2" when essential and a criterion of exclusion. In the end, the suitability of each method is represented by its ranking score, which is a weighted sum of the input weights and the method-specific mapping values in the DMM. In addition to those case-specific criteria of exclusion, global ones are considered, which act as contra-indicators for specific OI methods, like *missing Lead Users* for a Lead User workshop.

5.4.6 Evaluative summary of existing method selection approaches

None of the presented approaches is completely suitable for selecting OI methods as all of them have specific benefits and limitations. Table 5-6 summarises the degree of requirement fulfilment of the previously presented and analysed approaches.

Method models are an essential basis for systematically characterising methods. They therefore build the basis for any systematic OI method selection, including the depiction of specific advantages and disadvantages. Due to their clear and standardised structure, further methods can be added at any time. Although this standardised structure supports a comparison of different methods, method models only allow a discursive ranking and selection process. Therefore, the results of the selection process depend on the experience of the users, which exacerbates a direct use in SMEs. Another shortcoming is the missing OI perspective existing method models. The method model of KIRSCHNER (2012, p. 92) addresses open collaboration methods but from the perspective of open product development, which slightly differs from OI. In addition, his model does not support an automated method selection, along with a varying level of abstraction of the comprises "methods". In summary, the existing method models are not directly suitable but can serve as basis for the development of an OI-specific method model.

Decision trees allow an intuitive selection of OI methods, which does not require specific expertise. Due to its structure, the most relevant selection criteria are located at the beginning of the decision process, and inconsistent decision paths are already excluded when developing the decision tree. The selection process is traceable at any point due to the distinctiveness of paths. However, along with a lacking focus on OI methods, decision trees are only suitable for a small number of decision criteria. With a growing number of criteria, the complexity increases and the usability decreases. In addition, they do not support a ranking of methods nor a differentiated consideration of suitability in regards to OI situation and OI partners.

Portfolios support an intuitive and easy selection of OI methods since the complex selection process is reduced to only two dimensions. This allows a comprehensible overview of all potential methods and highlighting of the most suitable ones, which is particularly relevant for industry. However, the dimensions often only serve for structuring and not comprise a detailed scale. Therefore, the final ranking and selection is based on discussions of the OI team, and the regarding experience of its members. The consideration of only two dimensions also is a strong simplification and limitation as it does not allow a holistic assessment of a method's suitability. While further methods can easily be added into the portfolio, an independent implementation within a software is not reasonable since the portfolio can be considered to be only a figure. Nevertheless, a portfolio can be used to present the results of a preceding ranking process.

The analysed **software-based selection tools** can be differentiated in web-based and app-based tools. While the **web-based WiPro and Methodos** tools allow an intuitive use also for inexperienced users, the **app-based InnoFox** requires knowledge about the underlying engineering model iPeM. In contrast, InnoFox provides a ranking of suitable methods, while the web-based tools only use a filtering mechanism. The latter contradicts the demanded transparency of rankings. Although InnoFox and Methodos consider the user of the tool, the primary focus of all selection criteria is on context factors without evaluating OI partners. InnoFox and Methodos provide detailed information about methods including strength and weaknesses. WiPro only gives a rough overview of its methods. As all tools are encapsulated software systems, it is not possible to check the actual selection process or autonomously enhance the tools by additional methods. In addition, they lack a particular focus on OI.

Scoring-based selection processes allow an intuitive selection of methods as users only need to assign a weighting factor to the selection criteria due to their relevance. The DMM allows to check all mapping values as well as to include new OI methods by adding a further column in the DMM. However, DMM-based approaches become increasingly complex with a growing number of selection criteria due to their direct mapping of selection criteria and methods. Due to this combination of selection criteria and method characteristics, the resulting method profiles might be not consistent as specific characteristics do not apply for all methods. In addition, the user input is only rudimentary as it only allows the statement if a criterion is relevant or not. In general, the presented DMM approach does not consider a differentiated assessment of a situation- and partner-specific suitability of methods nor does it indicate specific advantages and disadvantages.

Table 5-6: Requirement analysis of existing method selection approaches

Selection of OI methods	**Method models**	**Decision trees**	**Portfolios**	**Web-based**	**InnoFox**	**DMM-bases selection**
Supporting the selection decision	◔	●	◑	◕	●	●
Ranking OI methods regarding their situation and partner suitability	◔	N/A	N/A	◔	◑	◑
Ensuring transparency of the ranking process	N/A	●	●	◔	◔	●
Showing advantages and disadvantages of each OI method	●	○	○	●	●	◑
Allowing a future enhancement by further OI methods	●	◑	●	◔	◔	◕
Ensuring an intuitive and easy use of the selection approach	◔	◕	●	●	◑	●
Allowing a criteria- and software-based selection process	○	◑	○	●	●	●

5.5 Evaluative summary of the state of art

As this chapter shows, a holistic approach for planning OI projects in SMEs does not exist. A therefore more broaden literature analysis revealed that even existing approaches for OI in general show different shortcomings: the majority of them are too abstract for an application in industry since they either only state **what** needs to be done but not **how** (e.g. HUIZINGH 2011), or they only provide descriptive statements and structuring concepts but no prescriptive operative guidelines (e.g. FETTERHOFF AND VOELKEL 2006). Other sources are (single) case studies, which describe in detail the planning and execution of OI projects in specific companies but are hardly generalizable nor contain prescriptive instructions (e.g. BILGRAM et al. 2013). Quantitative studies focus on specific aspects or dependencies of OI and do not allow a holistic planning of OI projects – along with a missing prescriptive character (e.g. PAASI et al. 2010). Similarly, existing prescriptive support focusses on particular aspect of OI, such as OI methods and OI partners, but are not suitable for planning OI projects in general (e.g. GASSMANN 2013). Therefore, this chapter goes a level deeper by identifying and analysing existing approaches from the single research gaps, selected in chapter 3.3: i.e. analysis of OI situations, search for OI partners and selection of suitable OI methods. The assessment of each approach regarding the SME-specific requirements from chapter 4.4 revealed also a lack of holistic methodical support within the single research gaps. Nevertheless, the requirement analysis also indicated specific elements of each approach, which can be adapted and utilised within a methodology for planning OI projects, as well as open needs of new elements.

6. Derivation of the basis of an Open Innovation planning methodology in SMEs

This chapter bridges the analysis of the state of the art and the development of an integrated methodology for planning OI projects. Within the research context of OI projects in product development (chapter 2), SME-specific research gaps were identified in empirical and literature-based studies (chapter 3). Out of them, three prioritised research gaps were derived, which are particularly relevant for OI projects in SMEs that have no experience with OI. To purposefully solve these gaps, a SME-specific requirement analysis was conducted (chapter 4). By mirroring existing approaches onto these requirements (chapter 5), their SME-specific strengths and shortcomings are derived. These serve as basis for deriving a general structure of an integrated planning methodology in this chapter. In addition, suitable elements of existing approaches as well as open sub-gaps of required new elements are deduced.

6.1 Evaluative summary of general methodical support

Along with the identified requirements of supporting the planning of OI projects in SMEs (cf. chapter 4.4), BRAUN (2005, p. 153) states **general requirements when developing methodical support in SMEs**. He links the specific requirements to the type of task, which needs to be supported, and the users of the methodical support. In respect to the required OI planning methodology, this means:

The **goal of this dissertation is to support the planning of OI projects**. This includes necessary planning steps and activities as well as their sequence. Along with this, the dissertation also aims at supporting in executing the specific planning activities by selecting useful planning methods. In addition, it also supports in selecting appropriate OI methods. In respect to the detailed planning of the OI method application, the dissertation indicates necessary adaptations and remarks for application. As explained in chapter 2.4, SMEs usually have a **lack of experience and expertise in respect to systematic planning processes** along with a lack of knowledge about the existence and efficient utilisation of specific methods. Therefore, the majority of users has a high need of an easily accessible and comprehensible operative support. Nevertheless, the OI planning methodology also needs to consider more experienced users, who might only need support or methodical inspiration for specific planning aspects.

For this case, BRAUN (2005, p. 153) proposes the development of a **generic guideline**, i.e. a modular methodology comprising different phases that can be adapted to different application contexts, as shown in Figure 6-1. To support in particular inexperienced users, the generic guideline should comprise a **pre-configured standard procedure** that leads users step-by-step through the planning process – similar to the standard procedure of the Munich Procedure Model (LINDEMANN 2009, p. 50f). Within the phases of the methodology, inexperienced users are supported by **suggestions of suitable methods**, while more experienced users get a sufficient **decision support** for selecting suitable methods.

In general, the OI planning methodology needs to find a balance between academic precision and applicability in SMEs. Due to their limited time and resources, SMEs prefer pragmatic methodologies, which generate results rather immediately. Along with this, GASSMANN AND SUTTER (2008, p. 9) also state that more data does not automatically bring better results. It often even bears the risk of a false impression of precision. In this respect, a **mixture of qualitative and quantitative approaches** in combination with open **discussion** of facts and results appears to be most effective.

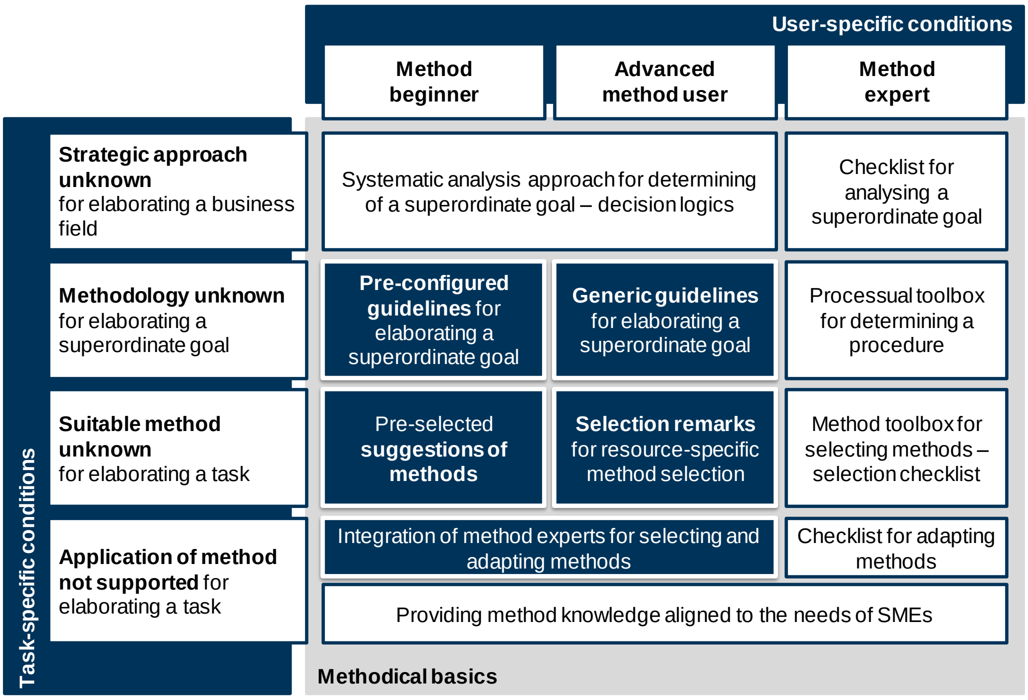

Figure 6-1: General requirements of methodical support in SMEs, and highlighted focus of this dissertation (based on: BRAUN 2005, p. 153)

From the requirement framework of BRAUN (2005) in Figure 6-1, the need for a **flexible character** of the OI planning methodology is derived. This correlates with GASSMANN et al. (2010, p. 216), who state that iterative and interactive planning models are more suitable for OI than linear and inflexible ones. In general, iterations are a central element of product development and need to be considered and sufficiently managed (WYNN AND ECKERT 2016, p. 29). LORENZ (2008, p. 145) states the general need of companies for guiding frameworks that are flexible and adaptable to the specific project's context, and allow forward and backward jumps, which is in line with ALBERS et al. (2005), (COLOMBO et al. 2011, p. 182) and LINDEMANN (2009). Therefore, the OI planning methodology comprises **different phases** that allow a **flexible, case-specific access into the methodology** as well as jumps and iteration when intermediate results are insufficient or boundary conditions change. Phase numbering indicates a standard procedure, which provides guidance to inexperienced users. Since iterations are time and resource expensive, it is necessary to support the user of the methodology in identifying the need of jumps as well as where to jump. Although the Stage-Gate Model itself is strictly linear (COOPER 2001, p. 138), the concept of its *gates* can be adapted for the OI planning methodology: they allow a systematic control of the planning progress, for instance, by using reflexive control questions (cf. GASSMANN 2013, p. 181).

To consider the increasing level of detail during the planning process, the methodology's phases are distinguished in rough and detailed planning phases. This concept of **level structure** (or *levels of resolution*) is a key-feature of the spiral model (BOEHM 1988) but is also supported by other engineering models and researchers (cf. chapter 2.2.4), such as ALBERS et al. (2005), GIAPOULIS (1998, p. 101) and LINDEMANN (2009, p. 38) . The **rough planning phase** defines the OI partners and OI methods as well as general project management aspects. In the **detailed planning phase**, the particular acquisition measures, start and end date of an OI method and other details are defined. In an ideal case, all major iterations take place on the rough planning level. Iterations on a detailed level should be avoided due to the particularly high planning effort.

Analysing the **structure** of different engineering models, such as ALBERS et al. (2005, p. 5), BERGMANN et al. (2009, p. 144), LINDEMANN (2009, p. 46f) and ULRICH AND EPPINGER (2008, p. 14), shows the great importance of **analysing the goal and the boundary conditions of projects** in the beginning of the planning process. This is particularly relevant for OI projects as they are situation-dependent (DITTRICH AND DUYSTERS 2007, p. 512; SOLESVIK AND GULBRANDSEN 2013, p. 15). OI projects need to be tailored to the specific boundary conditions and constraints of the company (HUIZINGH 2011, p. 5; LOREN 2011, p. 10). AS HOSSAIN (2015, p. 5) states, suitable OI partners and OI methods depend on the particular goal of the OI project. The planning of the OI goal also defines the direction and constraints of the OI project, for instance, by defining the solution space and the minimum level of secrecy.

Since the research gaps form consistent units, they serve as basis for deriving the other phases of the OI planning methodology. The second phase addresses the search of OI partners as they represent sources and recipients of knowledge and therefore are the central element of an OI project. Subsequently, the particular way of knowledge exchange is defined by selecting suitable OI methods. Since OI partners and OI methods are closely linked, the corresponding selecting processes represent a kind of matching process. After selecting OI partners and OI methods as core elements of an OI project, other aspects of project management can be planned, such as incentive strategies for OI partners, performance measurement and controlling, and risk management. As derived in chapter 3.3, the primary focus of this dissertation is on analysing the specific OI situation, and selecting OI partners and OI methods.

6.2 Evaluative summary of analysing Open Innovation boundary conditions

The analysis of the state of the art showed the lack of both, a definition of an OI situation and an OI situation analysis itself (chapter 5.2.1). Therefore, firstly, it is necessary to define an OI situation sufficiently, before developing an OI-specific situation analysis. The evaluation of general *situation* definitions and of *design situations* revealed three main characteristics (LINDEMANN 2009, p. 336; PONN 2007, p. 44; REYMEN 2001, p. 56): (1) a situation represents a specific state and **dynamic**, and (2) considers **different perspectives**, (3) which are **assessed by criteria**.

Criteria with distinctive specification scales are also essential for a subsequent tool-based selection of suitable OI methods and OI partners. Along with these ***heuristic*** **criteria**, qualitative ***reflexive*** **criteria** are important. They do not directly affect a decision in the planning process but enable an explicit reflection of implicit context factors and ensure a homogenous knowledge level within the interdisciplinary OI team. The collected situation criteria, attained from literature, come from different disciplines and vary in terms of distinctiveness, assessability and stated specification scales, which affects their applicability in industry. In addition, their specific relevance to OI projects is not proved. Therefore, it is necessary to **evaluate these potential OI situation criteria** in terms of distinctiveness, comprehensibility, measurability and relevance to OI projects.

As described in chapter 5.2, an appropriate clustering of OI situation criteria is important for an efficient future application. Based on literature, these categories are **company-internal criteria** (ERTL 2010, p. 70f; HUIZINGH 2011, p. 4; SARKKINEN AND KÄSSI 2013, p. 2), **company-external criteria** (ERTL 2010, p. 70f; HUIZINGH 2011, p. 4; SARKKINEN AND KÄSSI 2013, p. 2) and **OI goal specific criteria** (HILGERS et al. 2011, p. 89). Along with affecting the suitability of OI partners and OI methods (HOSSAIN 2015, p. 5), the latter also includes characteristics of the innovation object, for instance, a previous version of a product. As R&D projects are seldom greenfield developments, previous product versions set constraints for the possible solution space of R&D projects and comprised OI projects (cf. ALBERS et al. 2015b; 2015c). A **company's collaboration experience** is added as a fourth category based on the results of an industry study (GUERTLER et al. 2014b) and in accordance with ILI (2009, p. 119). The experience with previous OI projects, or collaborations in general, influence the employees' motivation and attitude towards collaboration projects (cf. ILI 2010, p. 417f) as well as external partners and knowledge, for instance, in terms of the *NIH syndrome* (ENKEL 2009, p. 189; KATZ AND ALLEN 1982). Prior partnerships can also bear strategic risks from an external point of view in terms of revealing a company's core competence (LI et al. 2008, p. 318f). This needs to be considers since it requires different incentive strategies.

In addition, HALES AND GOOCH (2004, p. 20f) and MEIßNER et al. (2005, p. 73) recommend to consider different ***levels of resolution*** for a situation analysis. In line with chapter 6.1, the OI planning approach comprises different levels, which also indicate the underlying dynamics of associated criteria: While the company-internal and -external criteria address a general long-term situation of a company, the collaboration experience is dependent on the business area and OI project team, and needs to be updated more frequently in a medium-term perspective. The fourth category needs to be assessed independently for each OI project on a short-term basis.

6.3 Evaluative summary of identifying and selecting Open Innovation partners

As already proposed by GOULD (2012), applying stakeholder analysis brings benefits for OI. The analysis in chapter 5.3 proves the complementary character of stakeholder analysis and Lead User identification in respect to OI. While the latter focusses on an **operative technical perspective** in terms of required skills and expertise of OI partners, stakeholder analysis addresses a **strategic perspective** for ensuring the success of an OI project, i.e. for instance, interests and dependencies between OI partners. Therefore, both approaches setup the base frame of an integrated OI partner search methodology. The analysis of different processes of stakeholder analysis and Lead User identification reveal a general search process structure.

Before searching for OI partners, it is crucial to examine existing stakeholders and their relationships, since they represent potential OI partners as well as supporters and opponents of the OI project. To determine this **current partner state**, stakeholder analysis methods can be used as they are specifically designed for identifying stakeholders and analysing their characteristics and interrelationships. Nevertheless, the literature analysis revealed that the existing variety of search methods (such as brainstorming, search directions and graphical searches) are usually rather unsystematic and need to be adapted to allow a sufficient application in SMEs. Along with analysing the current partner state, the **target partner state** needs to be defined in terms of required OI partner characteristics, like specific competences. Subsequently, the particular **delta between current and target partner state** is derived to evaluate, whether enough potential OI partners are already known or new, hitherto unknown OI partners have to be identified. This issue is essential for SMEs as they have only limited resources for an OI partner search and, as any company, want to gain results as fast as possible. Different methods are suitable for the **actual search** depending on the goal and boundary conditions of the OI project as well as type of required OI partners. To support method users from industry, these search methods need to be characterised sufficiently (such as effort and purpose) to allow an effective selection. Subsequently, known and new potential OI partners have to be **assessed regarding their relevance to the OI project**. Along with their potential for an operative involvement for solving the given problem, their strategic relevance has to be evaluated to allow a **holistic ranking of potential OI partners**. In addition, **partner-specific risks** shall be identified and considered for the final selection of OI partners. This is closely linked to the derivation of **suitable involvement paths**, i.e. which OI partners contribute operatively to a solution, and which OI partners are involved strategically to ensure the success of the OI project. The operative involvement is realised by OI methods. Due to the specific complexity, their selection is considered in the subsequent phase of the OI planning methodology.

6.4 Evaluative summary of selecting suitable Open Innovation methods

Basis of the selection of suitable OI methods is a structured characterisation of their specific procedures, advantages and disadvantages in form of a method model (chapter 5.4). To date, a sufficient OI-specific method model does not exist, and general method models are often too complex for a use in industry. Therefore, an **OI-specific method model** is developed, whose characteristics and specifications are manageable (as few as possible criteria), distinguishing (OI methods can be differentiated), clear (comprehensible for users) and definite (reproducible definition of specifications) as stated by SAUCKEN et al. (2015, p. 209).

For the selection process, **method characteristics and selection criteria are decoupled** as they are not entirely congruent. Often several decision criteria influence one characteristic and vice versa, for instance, the size of the involved group of OI partners is affected by available resources as well as by the need of secrecy (as fewer OI partners can be better controlled). In addition, on one side, OI situation and OI partner analyses as source of selection criteria, and on the other side, the OI method model can be independently enhanced, for instance, by adding new OI methods. By the use of a **matrix-based approach**, selection criteria and method profiles (as instances of the method model) can be modelled as vectors, which are connected via a DMM. The suitability score of each OI method can be calculated as scalar product of both, vectors and the DMM. This also allows an efficient handling of multiple decision criteria, which can be differentiated in OI situation and OI partner-specific criteria and be mapped onto OI method characteristics via two separate DMMs. In the end, this enables two regarding ranking scores for each OI method. Using the advantage of an intuitive visualisation, these can be depicted in a two-dimensional ranking within a **portfolio,** in terms of suitability for the OI situation and to different OI partners. Since each OI method has its specific strengths and weaknesses, they need to be highlighted, i.e. in the form of reasons that support the use of a specific OI method, contra-indicators and indicators for adaptations. To allow an efficient handling of selection criteria and the DMMs, the selection methodology needs to be **implemented within a software tool**. Since a selection methodology cannot consider all theoretically possible OI project situations, a discursive element is important, which allows the OI team to effectively discuss and reflect the derived OI method rankings. In this respect, a graphically edited version of the OI method profiles can support a comparison of characteristics of the pre-filtered and ranked OI methods.

7. Situational Open Innovation for planning Open Innovation projects

*This chapter presents the methodology of **Situational Open Innovation (SOI)** as methodical guideline based on the systematic analysis of existing partial approaches concerning SME-specific requirements. Subsequent to the presentation of the general structure and focus of SOI, each of its five phases is described in detail. This comprises specific activities, methods and tools as well as aspects and indications for adaptions and scaling.*

7.1 Introducing the methodology Situational Open Innovation

The developed methodology (as methodical guideline) addresses the planning of outside-in OI projects with a particular focus on analysing relevant boundary conditions, selecting OI partners and deriving suitable OI methods. The preceding strategic decision for OI as well as all succeeding activities, such as the execution of the OI project and operationalisation of gained knowledge, are not part of the methodology (cf. Figure 1-1). SOI supports OI teams in navigating through the planning process of an OI project by providing operative and prescriptive guidance and instructions.

7.1.1 The methodology Situational Open Innovation

The methodology **Situational Open Innovation (SOI)**, in German also ***Situative Open Innovation***, was initially presented in GUERTLER AND LINDEMANN (2013) as a methodical framework, which was detailed and enhanced by subsequent research activities in the context of this dissertation. The term ***situational*** stresses the fact that each OI project as well as each planning methodology depend on and need to be adapted to the specific situation of the project and company, i.e. to the project's goal, boundary conditions, contexts and constraints (DITTRICH AND DUYSTERS 2007, p. 512; HUIZINGH 2011, p. 5; SOLESVIK AND GULBRANDSEN 2013, p. 15).

Based on insights from initial evaluations in industry, the phase sequence of SOI was slightly adapted since its first presentation in 2013. Figure 7-1 illustrates the structure of methodology and its five phases. The four phases in the outer ring represent the **rough planning** of the OI project (*"What? Who? Why?"*): in the beginning, **SOI-1** analyses relevant boundary conditions and objectives of the OI project since they define the frame and constraints for all following project activities. Based on this, **SOI-2** identifies, ranks and selects relevant OI partners. Subsequently, **SOI-3** derives suitable collaborative OI methods to operatively involve the selected OI partners in the context of the specific OI situation. Depending on the results of the previous phases, **SOI-4** plans appropriate incentives strategies, performance measurement and project controlling, and risk management. **SOI-5**, as centre of the methodology, represents the **detailed planning** phase (*"How?"*) of the hitherto only roughly defined project elements. This includes, for instance, the definition of the specific start and end date of an OI method, the amount of monetary incentives and the members of the jury that evaluates external ideas.

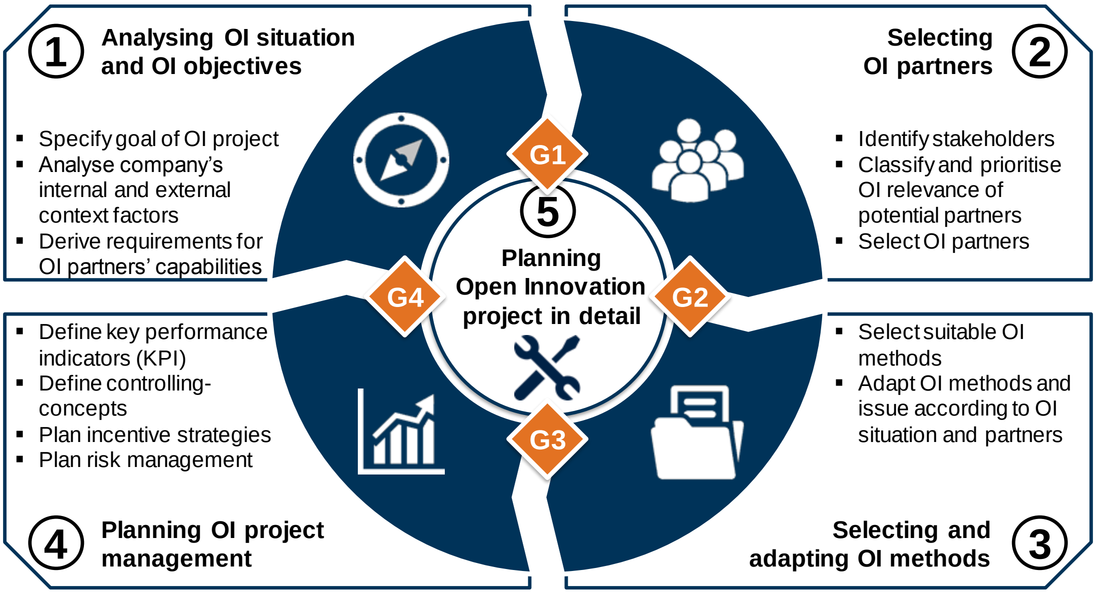

Figure 7-1: The methodology Situational Open Innovation (SOI)

While iterations should be avoided in the detailed planning due to the related effort, the rough planning allows **iterations**, as indicated by the arrows. They can, for instance, be necessary due to the matching process of OI partners (SOI-2) and appropriate OI methods (SOI-3), or due to the gain of insights during the planning process, or changing boundary conditions that force the OI team to adapt their planning. For instance, the **ranked list of alternative** OI partners allows to switch to lower ranked OI partners when the favoured OI partners evince to be unsuitable in subsequent phases. The derivation of alternative OI partner-method combinations builds an inherent pool of **backup** combinations, which can be used if the actually selected combination turns out to be unsuitable during the execution of the OI project.

To allow **purposeful iterations** and an effective planning process, an adapted and simplified form of the Stage-Gate Model (COOPER 2001, p. 131f) and decision gates from systems engineering (HASKINS 2006, p. 7.1) is utilised: The **gates G1-4** comprise control questions concerning the planning progress and appropriate jumps in other phases if necessary.

The overall goal of SOI is **supporting OI teams in operatively planning OI projects** by providing a structured guideline of planning activities and corresponding decision support. This means, information is analysed, processed and presented in a comprehensible form for the OI team, but SOI does not make the decision itself.

7.1.2 Setting up the Open Innovation team

An essential success factor of planning an OI project is putting together a suitable OI team that is responsible for all planning activities, the project's execution and coordination of the operationalisation of gained results. Due to the uniqueness of each OI situation and project, the planning process depends on the individual experience, competences and knowledge of the OI team members, to identify and assess potential OI partners. In the sense of **systems engineering** (cf. HASKINS 2006, p. 2.1) and **core team management** (cf. ALBERS AND MEBOLDT 2007, p. 2), it is important to bring together experts from different departments and disciplines, and combine their experience with the company and with external collaborations (KARLSEN 2002, p. 23; LOREN 2011, p. 10; LORENZ 2008, p. 150). A sufficient team composition can compensate individual knowledge deficits, subjectivity of assessments and other biases (KAIN et al. 2009, p. 194; VARVASOVSZKY AND BRUGHA 2000, p. 340). This is also relevant as SOI provides decision support, but all results of the methodology need to be discussed within the OI team to derive the actual decisions.

OI projects focus on involving external actors to solve a specific problem, but also require internal capacities. Thus, it is necessary to address this dimensions by the single team members. This means, the OI team comprises at least (1) one expert of the **speciality department** which seeks for a solution for one of their problems. He acts as *technology promotor* (HAUSCHILDT AND KIRCHMANN 2001, p. 42) and is necessary to concretise the objectives of the OI project and define the final task description. (2) A member of the company's **innovation management**, or respectively a product development manager, provides department-spanning organisational knowledge. He needs to be complemented by (3) an expert with knowledge about the company's environment, for instance, from the **purchasing, marketing or sales department**. Both can be considered as internal respective external *process promotors* (HAUSCHILDT AND KIRCHMANN 2001, p. 42). In addition, (4) a **member of the top management** should support the OI project as *power promotor* and ensure the strategic internal support by employees as well as the provision of necessary resources (HAUSCHILDT AND KIRCHMANN 2001, p. 42). However, he does not need to be involved permanently and operatively. In terms of using synergy effects, but avoiding communication efforts and reduced identification with the team, the size of the **core team** should be around four, maximum eight members (LINDEMANN 2009, p. 29). To avoid conflicts, it is important to assign specific team roles and responsibilities to each team member.

Along with the **OI core team**, **further experts** can be involved on a demand-base (cf. ALBERS et al. 2005, p. 7; PMI 2013, p. 37), for instance, when assessing specific OI partner groups or formulating the conditions of participation of an OI method.

7.1.3 Soley as basis of the SOI software demonstrator

To allow a more efficient application in industry and reduce the efforts of data handling, the OI partner search methodology of SOI-2, is implemented as a software demonstrator. The underlying software platform is *Soley Studio* (www.soley.io) a spin-off of the Chair of Product Development and based on the results of the dissertations of HELMS (2013) and KISSEL (2014). It is a graph-based big data analysis platform that supports product developers in collecting and analysing distributed knowledge and data within a company. Soley users can program individual data processing and analysis algorithms for their specific problems and tasks with Soley Studio as a programming platform. These solutions are comparable to smartphone apps and can be loaded and used in the free *Soley Desk*.

7.2 SOI-1 – Open Innovation situation analysis

The analysis of the project and company-specific OI situation is the basis for all subsequent OI project activities from project planning, via execution to the operationalisation of gained knowledge. It specifies the overall goal and subordinate objectives of the OI project, scope of action and constraints in terms of technical degrees of freedom, available time and resources. Based on the specific OI situation, different OI partners and OI methods are suitable, including the likeliness of resulting risks and barriers. Hitherto, a **definition of an OI situation** as basis for a profound OI situation analysis does not exist. Therefore, based on the definitions of design situations (chapter 5.2.1), it is defined as (GUERTLER et al. 2016b, p. 9):

"*In terms of SOI, a company's Open Innovation situation is a set of **internal and external** context factors, boundary conditions and characteristics of the OI project, which set the **specific and dynamic constraints** for an OI project and are **assessed using criteria**.*"

The following chapter develops a methodology for analysing an OI situation, based on intermediate results presented in GUERTLER et al. (2016b).

7.2.1 Dimensions of an Open Innovation situation

As described in chapter 6, four analysis dimensions of an OI situation are defined for SOI, as shown in Figure 7-2. The (1) **company characteristics** describe the internal organisational structures, processes and conditions of a company, while the (2) **company's environment** characterises the strategic market environment. The (3) **collaboration experience** assesses positive and negative experience with collaborations and the type of collaborations. The (4) **purpose and goal of the OI project** define the objectives and project-specific boundary conditions.

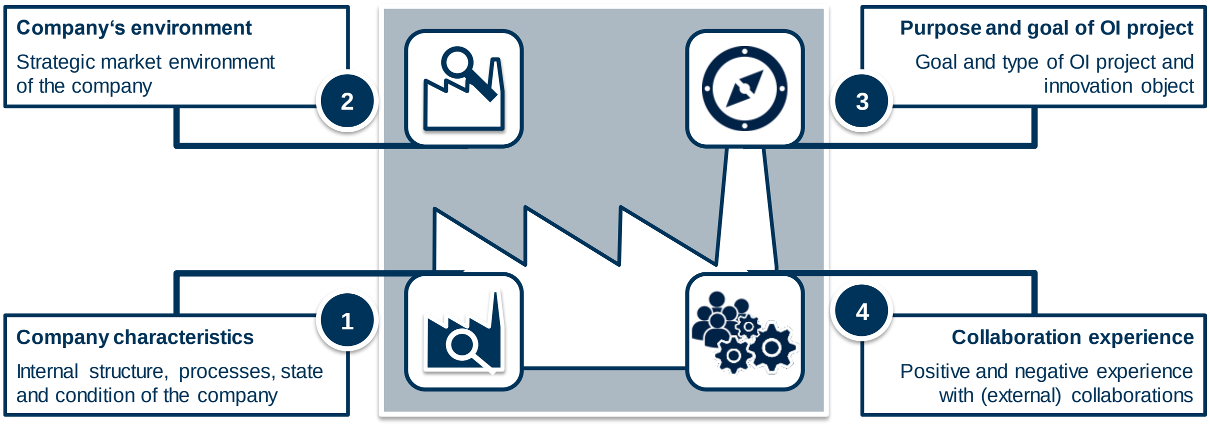

Figure 7-2: Four dimensions of an Open Innovation situation (based on: GUERTLER et al. 2016b, p. 10)

Along with a differentiation in these four categories, situation criteria can also be distinguished in heuristic and reflexive criteria. **Heuristic situation criteria** have distinctive specification scales and allow a ranking of suitable OI methods by specific algorithms, such as amount of available resources and need of secrecy. Although, these quantitative criteria are preferred as they allow distinctive cause-effect chains, they are not always sufficient due to the uniqueness of each OI project (cf. HENTTONEN AND RITALA 2013, p. 8). Therefore, qualitative and more subjective criteria are also required. **Reflexive situation criteria** comprise qualitative aspects, which are relevant for the OI project but do not directly affect a particular planning aspect. By fostering discussions and their documentation, implicit knowledge of individual OI team members is explicated to ensure a homogenous knowledge level within the entire OI team. This is particularly relevant as the OI team members come from different departments and have varying backgrounds.

As chapter 5.2 showed, there are no consistent situation criteria for assessing an OI situation. They differ in their level of abstraction, measurability and specification scales. Therefore, to develop an OI situation analysis, it is necessary to design a set of situation criteria, which are applicable in industry. As presented in GUERTLER et al. (2016b), an **initial set of potential situation criteria** was derived from literature and subsequently empirically evaluated and enhanced in terms of comprehensibility and distinctiveness, measurability (i.e. effort and access to relevant data) and riskless nature (i.e. data privacy and strategic sensibility issues).

The derived situation criteria were the basis for methodically and empirically **deriving relevant OI situation criteria**. As described in more detail in GUERTLER et al. (2016b, p. 15f), heuristic OI situation criteria were identified by mapping situation criteria and OI method characteristics by using a DMM. The reflexive OI situation criteria were derived empirically by observing and analysing the OI pilot projects in the context of the research project *KME - Open Innovation*. In the context of evaluating the applicability of situation criteria, the companies had answered the respective criteria. This allowed an academic workshop at the end of the three OI projects and the discussion of situation criteria that had turned out to be most relevant for planning and executing the respective OI projects.

7.2.2 Criteria for analysing an Open Innovation situation

The following sections present the derived OI situation criteria, structured into the four previously described categories. The lists of all evaluated situation criteria, including detailed literature references, can be found in the appendix 13.4 or in GUERTLER et al. (2016b). These general lists can be relevant when other researchers adapt the OI situation analysis to their specific needs in the future.

Discussions with the industry partners showed that actors from the corporate communications, controlling and marketing can support in assessing the **company-internal and external situation**, while actors from the business unit or speciality department are helpful for the **existing collaboration experience**. The **OI project-specific situation** can be best assessed by the OI team.

Analysing the company characteristics

Company characteristics assess the internal state, structure and processes of a company at a strategic, organisational and cultural level. They set the frame for all innovation activities within the company. For instance, the company strategy defines the superordinate goal of an OI project and principal focus on incremental or radical innovations. Some criteria are linked to environment or collaboration criteria, but are considered more relevant for the entire company. In addition, it can be useful to consider different analysis levels: when the internal situation criteria strongly differ for the entire company, the specific business unit and the department, a differentiated analysis is advantageous. Table 7-1 shows the OI relevant heuristic and reflexive company-internal situation criteria.

Table 7-1: Criteria for assessing the company-internal OI situation (also cf. appendix 13.4)

Criterion	Description	Specification scale
Reflexive criteria		
Company strategy	The company strategy influences the goal and boundary conditions of an OI project as well as of the entire innovation process.	technology leadership; quality leadership; cost leadership
R&D collaborations	Existing (external) R&D collaborations indicate experience with collaboration in general and with specific stakeholders in particular as well as potential dependencies from those stakeholders.	customer; suppliers; universities; others
Durability of strategic decisions	It indicates the time of validity of strategic decisions. It provides an orientation for the certainty of planning in the OI project, i.e. how likely is the strategic support for the entire duration of the OI project.	< 0.5 year; < 2 years; 5-10 years; > 10 years
Reflexive criteria		
Organigram of company	It gives an overview of a company's structure and interrelationships between business units. It can also serve as basis for the following stakeholder analysis.	
Corporate management	How is the company managed (by an entrepreneur; multinational consortium; public; etc.)? It is an indicator for business strategy, management support, planning certainty, etc.	
Degree of globalisation	How are the company's activities spread over the world? It is an indicator of the variety of potential internal stakeholders, whose requirements need to be considered, or who can serve as potential OI partners in the OI project.	

Analysing the company's environment

The company's environment is assessed on a strategic level. It defines the external boundary conditions and constraints of the company's innovation activities. Along with general aspects, such as industry and market dynamics, the number and strength of customers, suppliers and competitors are evaluated. In particular, the competitive situation defines the need for secrecy and the maximum possible openness of OI. Global influencing factors, such as laws, standards and norms are also considered. Table 7-2 and Table 7-3 depict the regarding criteria.

Table 7-2: Heuristic criteria for assessing the company-external OI situation (also cf. appendix 13.4)

Criterion	Description	Specification scale
Heuristic criteria		
Type of customer relationship	It specifies the main type of customers and is an indicator for the potential effort of acquiring OI partners, collaboration constraints (e.g. NDA) and incentive strategies.	B2B; B2C
Customer access	It specifies whether the company directly sells their product to their customers or via intermediate actors. This is an indicator of the level of knowledge about their needs and acquisition effort.	direct; indirect
Innovation cycle duration	It specifies the average time-to-market for a new idea and is a general indicator for potential time restrictions of an OI project"	weeks; months; years
Need of secrecy / concealment	It specifies the openness of knowledge exchange with external partners and the need of knowledge protection mechanisms. (**very high**: all information about results and the project itself should stay secret; **medium**: content and results should stay a secret; **very low**: no specific need of secrecy	very low; low; medium; high; very high

Table 7-3: Reflexive criteria for assessing the company-external OI situation (also cf. appendix 13.4)

Reflexive criteria	
Industry of company	What is the specific industry sector of the company and the specific business unit? The type of industry strongly influences the performance and success of an OI project.
Variety of customer groups	How many groups of customers with differing needs do exist? It indicates relevant groups of stakeholders which need to be integrated into the OI project.
Customer contact	Are there special web-platforms for selling the company's products? These can potentially be used for interacting with customers.
Price regulations	Do special price regulations exist which can limit the revenue and/or the solution space of the OI project (e.g. customs dues, roaming fees, etc.)?
Compulsory certifications	Do special certifications exist which can limit the solution space of the OI project (e.g. certification of electrical components limiting crowd-based designs)?
Influence groups	Do specific groups exist that can influence the competition situation? They indicate potential strategic OI partners.
Strategic cooperation	Does strategic cooperation exist within the relevant industry (e.g. associations)? They indicate potential strategic OI partners.
Compulsory cooperation	Do external stakeholders exist who can cause forced cooperation with competitors (e.g. OEMs wanting to avoid single sourcing and forcing two suppliers to share specific knowledge)?
Number of competitors	How many competitors exist in the main market? It indicates the potential threat by competitors and the resulting need of secrecy.
Dynamics of competitors	How often do new competitors enter the market? The frequency of competitors entering the company's market indicate the potential external threat of being substitutes or copied.

Analysing the collaboration experience

This category assesses the collaboration experience of the pertinent business unit. This is crucial for the success of any innovation project. Positive experience can lead to a high intrinsic motivation. Negative experience with specific partners, with OI, or with external collaboration in general requires specific incentive strategies to prevent operational barriers and opposition by employees (cf. STOLZENBERG AND HEBERLE 2009, p. 4f). Table 7-4 and Table 7-5 summarise the respective situation criteria.

Table 7-4: Heuristic criteria for assessing existing experience with external collaborations (also cf. appendix 13.4)

Criterion	**Description**	**Specification scale**
Heuristic criteria		
Number of collaborations	It indicates the amount of experience with external collaborations and specific partners like universities, suppliers and customers.	none; few; many
Specific OI experience	Indicates if existing experience and documentations as well as employees of the previous OI project can be utilised.	none; existing
Employees attitude to externals	How is the employees' attitude towards external partners? Do they "meet on equal footing"? It indicates the need and effort of motivating internal stakeholders, or potential threats like the Not-Invented-Here syndrome.	reserved; neutral; positive; very positive
Internal method department	Does one or more internal departments exist, which offer methodical support for product development teams?	none; existing
IT-collaboration system	Do online platforms, company suggestion systems, supplier platforms exist? They might be used for involving OI partners.	none; existing

Table 7-5: Reflexive criteria for assessing existing experience with external collaborations (also cf. appendix 13.4)

Reflexive criteria	
Applied collaboration methods	Which collaboration methods have been applied so far? This indicates a basis of experience, which can be used for the OI project.
Type of cooperation	Which communication methods with externals have been used (e.g. personal meetings, workshops, web-based, etc.)? This specific experience can affect the selection of OI methods.
Positive collaborations	Are there particularly successful previous or current collaborations? They can be used as success stories to convince internal stakeholders of the OI project.
Negative collaborations	Are there well-known failed collaborations? They need to be considered to mark-off the new OI project.

Defining the purpose and goal of the Open Innovation project

This category characterises the goal and general characteristics of the OI project. The definition of strategic and operative goals is essential for the planning of OI projects (i.a. HILGERS et al. 2011, p. 89). Along with the choice of OI partners and OI methods, it directly affects the measurement and controlling of the project's performance (KARLSEN 2002, p. 23). Other influencing factors are the intended type and level of innovation (BOSCHERINI et al. 2010, p. 1073), or the product lifecycle (PLC) phase and other aspects. For instance, while involving crowds with ideation contests is suitable for generating a large quantity of ideas in an early PLC phase, a cross-industry workshop might be more appropriate to identify and adapt process concepts in the production phase. Along with the selection of suitable OI partners, the level of intended innovation can also affect the behaviour of OI partners: focussing on radical innovations can increase the risk of knowledge drain and opportunistic behaviour of OI partners (LI et al. 2008, p. 320). Other situation factors and constraints include available resources, the project-specific need for concealment/secrecy, and the strategic allocation in the company. These are crucial for the success of the OI project and should also have some degree of flexibility and adaptability. On the one hand, available resources constrain the selection of OI partners and OI method. On the other hand, it can be beneficial to extend the resources when this allows the utilisation of an OI method that enables a long-term application or strategic advantages. Table 7-6 shows the OI project-specific situation criteria.

Table 7-6: Criteria for assessing the goal and setting of the OI project (also cf. appendix 13.4)

Criterion	Description	Specification scale
Heuristic criteria		
Primary OI project goal	What is the primary goal of the OI project? It affects suitable OI partners and OI methods.	identifying market/user needs; generation of ideas; solving a (technical) problem
Innovation object	What is the innovation object that shall be innovated by the OI project? It affects the type of OI partners, methods and necessary adaptions.	product; service; process; business case
Level of innovation	Which level of innovation shall be achieved in respect to the innovation object, by the OI project or a superior R&D project?	radical innovation; incremental innovation
Product-life-cycle phase	In which product-life-cycle phase is the innovation object located and shall be innovated? This affects e.g. the available number and type of suitable OI partners.	R&D phase; product conceptualisation and design; production; after sales and maintenance
Minimum maturity level of OI input	Which minimum level of maturity shall the gained OI input have? It affects e.g. the selection of OI partners and methods, and quantity and quality of OI input.	idea; concept; product
Modularity of innovation object	What is the level of modularity of the innovation object, e.g. in terms of number of components? The more modular a system the more suitable for OI, due to better distribution of single tasks to OI partners.	low; medium; high
Project's deadline	What is the timeframe of the OI project? It defines the maximum available time for each project phase.	months; half a year; more than a year
Available man power	What is the availability of (additional) workforce to support the OI project?	very limited; limited but negotiable; freely available
Available budget	What financial budget can be allocated to the OI project?	very limited; limited but negotiable; freely available
Reflexive criteria		
Superordinate innovation goal	What is the goal of a superordinate innovation strategy? It has to be considered and provides an orientation for activities of the OI project.	
Secondary OI project goal	Does a secondary goal of the OI project exist? Often companies that apply OI do not only focus on solving a problem but e.g. also aim at learning effects or improved reputation.	
Expected results of OI project	What is the type of the expected results of the OI project? It specifies the goal of the OI project and the minimum maturity level of gained knowledge.	
Modularity of process	How modular is the process belonging to the innovation object, e.g. in terms of process steps? It indicates the resulting efforts resulting from the changed innovation object.	
Other resources	Do additional resources exist that can be used by the OI project (e.g. 3D-printers, etc.)?	
Project-specific need for secrecy	Does the OI project's need of secrecy / concealment differ from the general one? Depending on the specific task it might be higher or lower.	
Members of OI team	Which company departments are directly involved in the OI team? Which one has the lead?	
Strategic location of OI project	Where is the OI project strategically located within the organisational and hierarchical structure of the company? It indicates the potential support of internal stakeholders. Usually the management support directly correlates with the support of employees.	

7.2.3 Realisation as an interactive software questionnaire

To increase the usability of the OI situation analysis, it was implemented as software-based questionnaire in Microsoft Excel. This facilitates the use of the regarding data in following phases of SOI, and avoids redundant data inputs and potential transfer mistakes between different programs. Thus, the questionnaire is combined with the OI method selection tool, and the analysis results can directly be used for ranking potential OI methods (chapter 7.4).

Figure 7-3 depicts the questionnaire of the **heuristic OI situation criteria**. The criteria are clustered in accordance to the four previously categories. Each criterion comprises a distinctive specification scale, from which the user can select the fitting specification via a drop-down list. It is also possible to weight criteria regarding their specific relevance on a scale from zero to ten. Starting from a default weight of five, single criteria can be weighted up or down. By a weight of zero, a criterion can be excluded for the following ranking process when it is not relevant for the specific OI project or not assessable. Another spreadsheet comprises the **reflexive OI situation criteria**. Although they do not directly affect the selection algorithm of OI methods, this allows a consistent storing of all OI situation criteria at one place. This further increases the usability since reflexive criteria are indirectly relevant as they might affect the discussion in the OI team and selection of proposed OI methods.

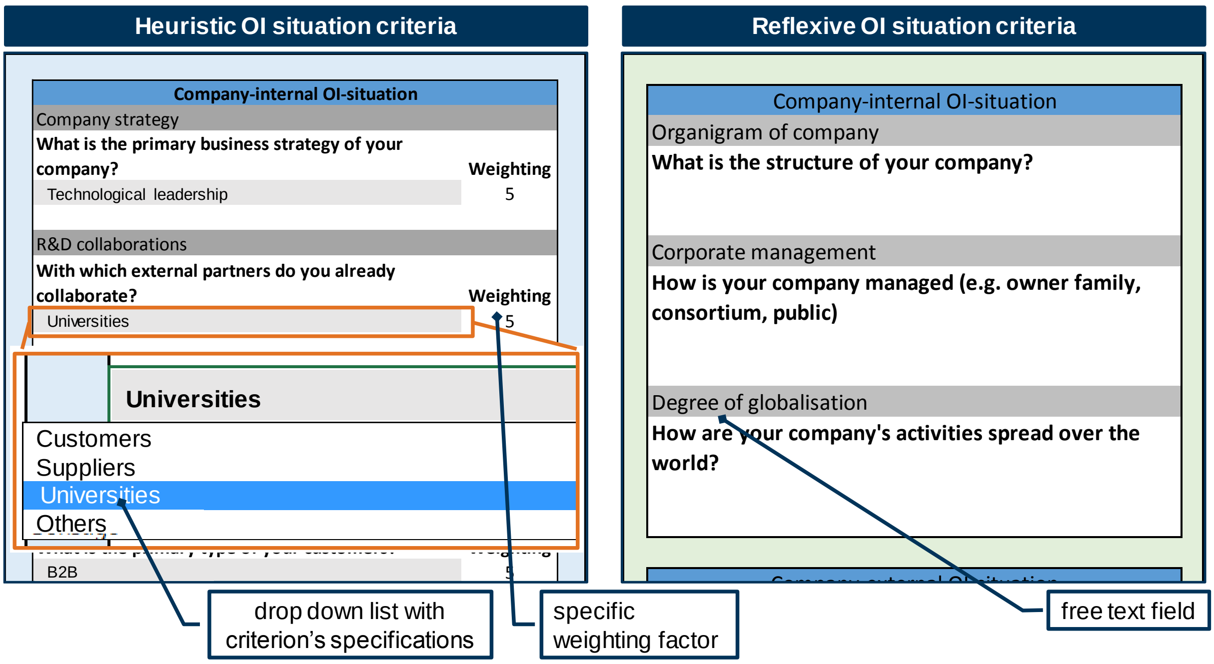

Figure 7-3: View of the Excel-based questionnaire for analysing an Open Innovation situation

7.2.4 Conducting a detailed problem analysis

To allow a sufficient planning of an OI project and determine potential operative problem solvers, it is essential to specify the respective problem and the resulting operative objectives, based on the analysis of the *purpose and goal of the OI project*. Nevertheless, often a direct specification of objectives is not possible due to a high complexity of the system. In those cases, a problem decomposition is necessary, i.e. to break down the "big problem" into small manageable parts for the problem solving process (cf. GIANNOPOULOU et al. 2011, p. 514f; LINDEMANN 2009, p. 115f; ULRICH AND EPPINGER 2003, p. 101). In addition, this allows the identification and prioritisation of alternative sub-goals.

Common ways of structuring a system or a problem are a **structural decomposition** of the system’s components and a **functional decomposition** of the system’s functions, both often in combination with a **hierarchical structuring** (ALBERS AND BRAUN 2011, p. 8; MAURER 2007, p. 31). While component models stay relatively close to the technical system and problem level, functional models particularly support in leaving fixations by abstracting the problem. This allows to analyse the problem on a different layer, uncoupled from the actual technical system. Three common function models can be distinguished: (1) relation-oriented function models, (2) flow-oriented function models, and (3) user-oriented function models (KREIMEYER et al. 2009, p. 119f; PONN AND LINDEMANN 2011, p. 61f; ULRICH AND EPPINGER 2003, p. 102f):

User-oriented function models focus on the interaction between users and a system, and are particularly useful when the OI project aims at improving the usability and the user interfaces of products. **Relation-oriented function models** analyse the intended useful functions for fulfilling the purpose of a system and harmful functions, which are caused by the useful ones. Along with their relationships, this also includes useful function that were introduced to prevent harmful functions. This allows the identification of weaknesses and aspects of improvement of the system in terms of unsolved harmful functions and useful function that cause multiple harmful functions. **Flow-oriented function models** are useful when the OI project focusses on systems that comprise or manipulate flows of material, energy and/or information. This kind of model analyses those flows in a system including inputs and outputs, as well as the functions, which manipulate the flows.

Along with the specification of tasks and objectives of the OI project, these models also support the analysis of the allowed solution space, or so called technical degrees of freedom (cf. LINDEMANN 2009, p. 127f). By this, it can be defined which elements and functions of the system are allowed to be changed by the OI project, and which have to stay untouched.

In general, component models are most suitable for incremental innovations as they stay close to the current system. The problem abstraction of functional models allows the transfer and solving of the problem in another solution space, which is more appropriate for radical solutions. Nevertheless, it is also possible to use combined component-function models.

7.2.5 Deriving requirements regarding OI project, OI partners and OI methods

The results of the situation analysis define general requirements and constraints for the subsequent planning phases and the subsequent OI project. Due to the uniqueness of each OI project in terms of goals and company context, it is difficult to state absolute situation criteria and requirements relationships. However, it is possible to discursively identify requirements and constraints of the specific OI project. Therefore, after the conduction of the OI situation analysis, the OI team should meet, and discuss and document each situation criterion and its affect onto the different aspects of the OI project, such as OI partners and risk management.

In general, the **internal OI situation** specifies the potential internal support and aspects of absorptive capacity to operationalise the project outcomes. The **external OI situation** affects the selection and adaption of OI methods as well as the communication and acquisition of OI partners. For instance, in the case of a highly competitive market environment and a resulting high need of secrecy, crowdsourcing methods are usually less suitable, whereas passively observing OI partner search methods are advantageous.

Existing experience with external collaborations affects the attitude of internal stakeholders towards the OI project, and its resulting company-internal "marketing". For instance, while the challenge with highly interested and motivated employees is to allow all of them to participate in the OI project, the challenge with unmotivated or refusing employees is to find appropriate incentive strategies, to gain their support or at least prevent boycotts in the worst case.

The **OI goal** and optional problem analysis define the operative technical properties, which potential OI partners need to contribute to solve the specified problem, as explained in the following chapter. Along with this, the scope and level of innovation is specified. Based on the work of LOPEZ-VEGA et al. (2016), this characterisation helps in identifying appropriate search paths in the subsequent OI partner search. For instance, as illustrated in Figure 5-2 (chapter 5.3.1), *situated search paths* within known knowledge areas are useful for local trial-and-error improvements, while *scientific search paths* outside of known knowledge areas are beneficial for new basic insights and radical innovations.

7.2.6 Control questions to evaluate the planning progress

The idea of control questions is based on GASSMANN (2013, p. 181f) and was adapted and enhanced for a use in SOI. The control questions in Table 7-7 and Table 7-8 support the OI team in reflecting the planning progress in terms of completeness and considering the most relevant outcomes of this phase. This provides guidance and orientation within the planning process, and also triggers project-specifically more detailed reflections within the OI team.

Table 7-7: Control questions to evaluate the OI situation analysis – part 1

Aspect	***Questions***
General aspects	• Who is the initiator of the OI project? Does he provide sufficient strategic support? • Does the OI team comprise members from different departments and disciplines? • Are there additional experts, who can be consulted when necessary? • Does a specific OI method implementation (e.g. ideation platform) exist, which shall be used within the OI project? In this case, the according OI method profile provides information about suitable types of OI partners, which can be used for narrowing down the scope of the OI partner search.
Goal and boundary conditions of the OI project	• What is the primary and secondary goal of the OI project? Are they realistic? • Is the problem and task definition distinctive and manageable within an OI project? • Is the intended OI project's outcome a high quantity of diverse creative ideas, or rather high quality solutions for a specific problem? • What are the constraints of the project (technological, strategic, time, resources)? • Does an intended product innovation also affect the production process? • Does an intended service innovation affect the related physical system (cf. PSS)? • Have all analysis results and decisions been documented?

Table 7-8: Control questions to evaluate the OI situation analysis – part 2

Aspect	***Questions***
Internal situation and experience with collaborations	• Does the company's culture and the attitude of employees support OI projects? • Are specific motivation measures required, such as incentives, internal marketing and management announcements? • Does the failure culture allow suboptimal OI outcomes or is there only one chance to successfully execute this OI project? • Does the OI team have sufficient freedom and space from their daily business to plan and run the OI project?
External situation	• Is the increased public awareness due to the OI project in line with the public relations (PR) and marketing strategy of the company? • Do specific strategic dependencies to other stakeholders exist, which need to be considered for the OI project? • How is the competitive situation on the market? How does it affect the required level of secrecy or the general choice of OI partners?

7.3 SOI-2 – Open Innovation partner search

This phase addresses the identification, assessment and selection of suitable OI partners. OI partners can be internal and external, single individuals and organisations, or groups of them as well as crowds (cf. chapter 2.3.2). In this respect, **all stakeholders are considered potential OI partners**, as shown in Figure 7-4. They represent a pool of known actors that can be involved in the OI project as actual OI partners. In addition to already known potential OI partners, specific OI projects can require the particular search for new, hitherto unknown OI partners, e.g. from other industry sectors.

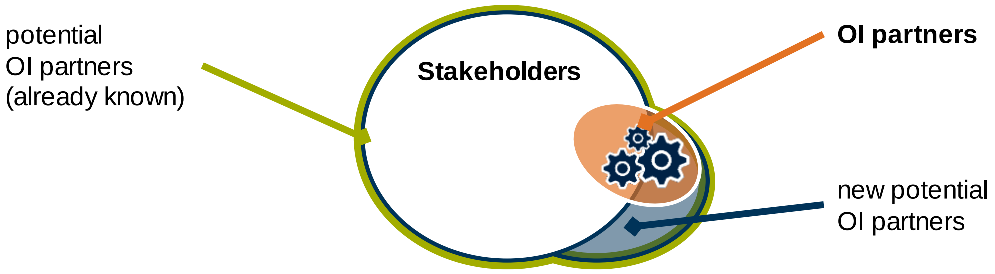

Figure 7-4: Differentiation of stakeholders, potential OI partners and actual OI partners

The search methodology to identify and select suitable OI partners consists of six steps (GUERTLER AND LINDEMANN 2016a, p. 7), as illustrated in Figure 7-5. While the (1) **first step** analyses and documents the current state of known potential OI partners and defines the target state in terms of necessary partner criteria, the (2) **second step** derives the delta between current and target state as well as potential search fields for new OI partners. These are the basis for a systematic search for new OI partners in the (3) **third step**. The (4) **fourth step** assesses known and new potential OI partners in respect to their OI project relevance and serves as basis for the ranking and selection of OI partners in the (5) **fifth step**. Closely linked to the selection of OI partners is the derivation of suitable operative and strategic involvement measures in the (6) **sixth step**.

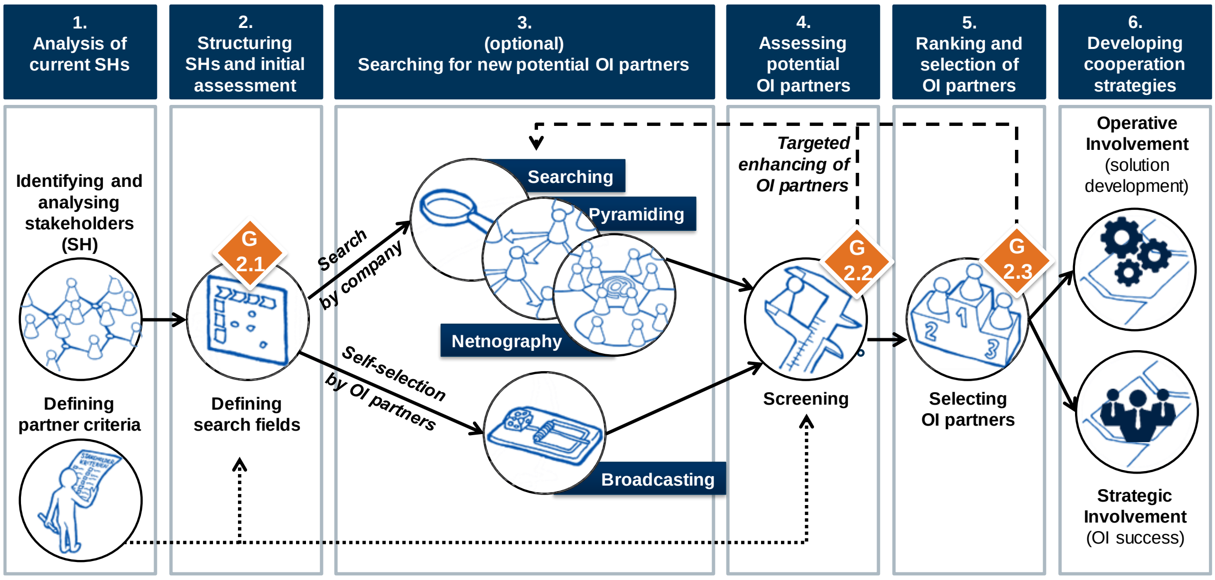

Figure 7-5: Sub-methodology for searching for Open Innovation partners (GUERTLER AND LINDEMANN 2016a, p. 7)

The steps are presented in detail in the following subchapters, describing their specific goal and purpose, inherent process and supporting methods and tools. To support the methodology's usability in companies, it was implemented as software demonstrator using the *Soley* platform, as described in chapter 7.1.3. The implementation was part of PE: ENDRES (2015) with close supervision and guidance of the author of the dissertation. The demonstrator comprises all search steps and their sequence in form of so called *workflows*, which summarise all related analysis algorithms and navigate the OI team through the OI partner search process. In addition, it provides a consistent data management, i.e. it reduces redundancies of data input and allows a direct use of this data for subsequent analyses without changing the software system. The particular software elements are explained in the corresponding steps of the OI partner search methodology. To increase the comprehensibility, the specific software implementation of each step is presented in a box at the end of each sub-chapter, according to the following one.

Soley: Overview of OI partner search software demonstrator

Figure 7-6 illustrates the standard view of the OI partner search demonstrator. Within the (1) **modelling window**, process phases, stakeholders, their dependencies and partner criteria are modelled by using pre-defined (2) **modelling elements** with specific characteristics. If necessary, their individual (3) **element properties** can be modified. All analysis activities and methods are implemented in so called *workflows*, that can be conducted via the (4) **workflow launcher**. Along with a short description of each workflow, the workflow launcher presents all workflows according to the sequence of the OI partner search steps (Figure 7-5).

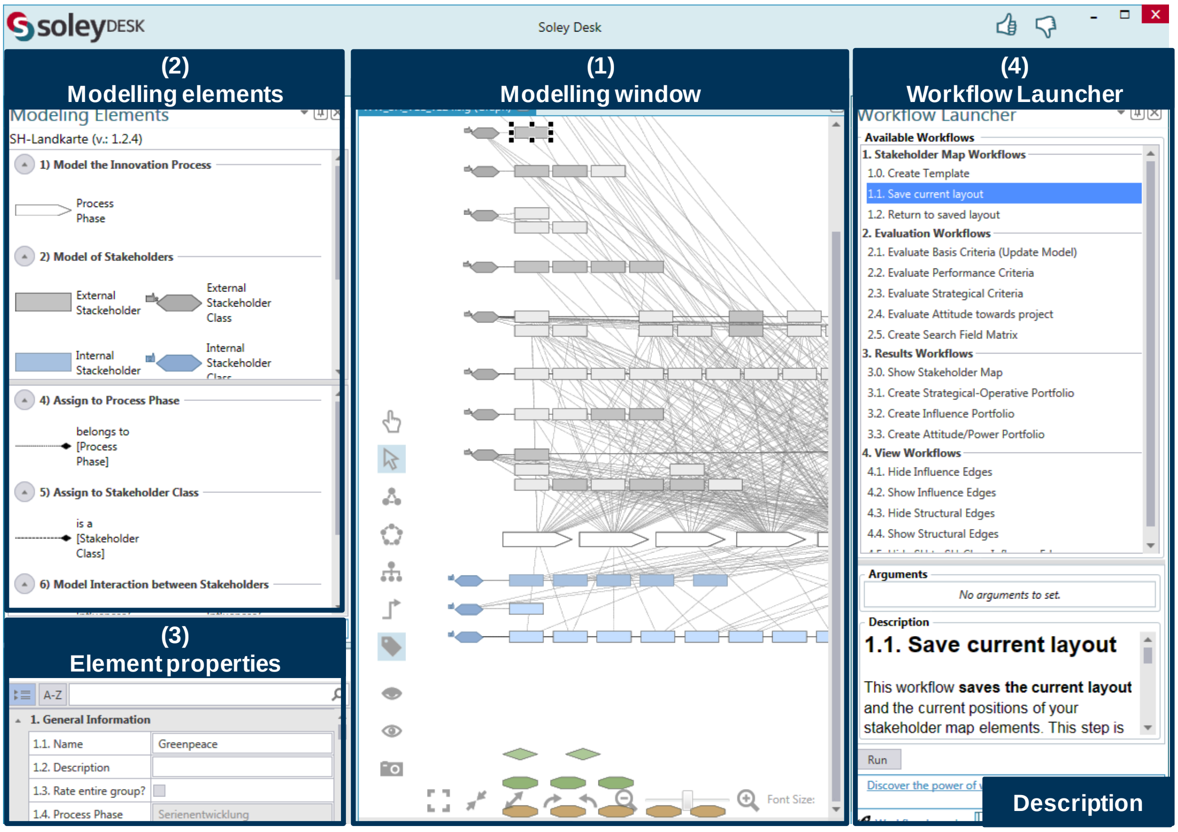

Figure 7-6: Overview of OI partner search software demonstrator

7.3.1 Analysing current stakeholders

The first step of the OI partner search methodology defines the target state of OI partners by specifying strategic and operative partner criteria as requirements of OI partners. They provide orientation for the search and also serve as assessment criteria for evaluating the project relevance of potential OI partners. In addition, the current state of OI partners is documented by identifying existing stakeholders of the company and the OI project and analysing their interests and interrelationships. This reduces the risk of neglecting actors who are relevant for the success of the OI project, such as powerful supporters or opponents.

Defining operative and strategic partner criteria

The partner criteria can be distinguished in strategic criteria and operative criteria (GUERTLER AND LINDEMANN 2016a, p. 7). They need to be defined project-specifically.

Operative partner criteria define the technical expertise and skills that OI partners need, to be able to contribute to a solution of the OI goal. The criteria can be derived from the analysis of the OI goal and the optional problem analysis (cf. chapter 7.2.4). As partner criteria represent requirements of OI partners and can differ in their specific relevance, it is necessary to weight them accordingly. Due to its wide adoption and comprehensibility, SOI recommends a criteria weighting based on a simplified version of the **KANO model** (MATZLER AND HINTERHUBER 1998; POHL AND RUPP 2010, p. 32f; REINHART et al. 1996, p. 46f): (1) **basic criteria** (*criteria of exclusion*, or "*must have*") define elementary characteristics of OI partners. They are assessed binary since they are that relevant that a non-fulfilment automatically excludes potential OI partners: for instance, expertise with steel and iron when developing a new steel alloy. (2) **performance criteria** ("*should have*") allow a differentiated assessment of the performance and suitability as well as a resulting prioritisation of OI partners: for instance: production capacities. If necessary, performance criteria can be additionally weighted, for instance, with linear or geometric scales[27]. This allows to consider differing relevancies of single criteria for the OI project. (3) **excitement criteria** ("*nice-to-have*") support a detailed differentiation of similarly ranked OI partners. However, they alone are not sufficient for assessing an OI partner's suitability: for instance, the existence of an own test laboratory. These three relevance categories allow an **efficient step-wise assessment** in the following. As basic criteria are essential requirements, OI partners can be excluded that do not fulfil all of them. Only the remaining OI partners are assessed concerning the performance criteria, which reduces the evaluation effort accordingly. The analysis of excitement criteria can be limited to the top group of favoured OI partners to further reduce the assessment effort.

Strategic partner criteria are indicators of the strategic relevance of OI partners in terms of their influence on the long-term success of an OI project. While operative partner criteria need to be independently defined for each OI project, strategic partner criteria are based on traditional stakeholder criteria (cf. chapter 5.3.3) and can be enhanced and adapted. The main criteria for SOI are the strength of **interest** and the **attitude** towards the OI project (MACARTHUR 1997, p. 253; VARVASOVSZKY AND BRUGHA 2000, p. 342), the **power or influence** onto the OI project and the corresponding **legitimacy** (MITCHELL et al. 1997, p. 867). When necessary the latter can be differentiated, for instance, in legitimacy due to a hierarchical position or individual credibility within the company (cf. GUERTLER 2014, p. 61). The urgency of stakeholders (MITCHELL et al. 1997, p. 867) is not considered as the industry partners stated it was rather difficult to assess due to the feedback of the industry partners during the evaluation.

For a successful OI project, it is important to consider both perspectives: the **operative perspective** is essential since OI projects focus on solving a specific problem, while the **strategic perspective** is crucial since it considers "soft" influences on the success of an OI project, such as personal or political interests. In terms of usability and assessability, each

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[27] While a linear scale is a linear line of integers ($\mathbb{N}_0$), geometric scales usually follow the rule $3^n; n \in \mathbb{N}_0$, and allow a better differentiation of cumulated values during the assessment step.

perspective should comprise around five criteria. To ensure a consistent assessment, all criteria should have similar **specification scales** (e.g. low, medium, high and non-assessable) and corresponding numeric values (e.g. a linear scale or a geometric scale). In addition, it is important to provide references to each specification scale, i.e. when is a criterion rated as low or high. An exception is the attitude of OI partners as it can be specified as positive, neutral and negative. All OI partner criteria have to be **documented** sufficiently to allow an effective search and assessment of OI partners, for instance, within a requirement list.

Modelling of partner criteria in Soley

Within the software demonstrator, partner criteria are modelled graphically. This visualisation supports the awareness of the OI team and triggers potential discussions, as illustrated in Figure 7-7. Operative performance criteria can be weighted individually when necessary. In addition, the value scale of their specifications can be adapted. In this case, all performance criteria should be adapted consistently.

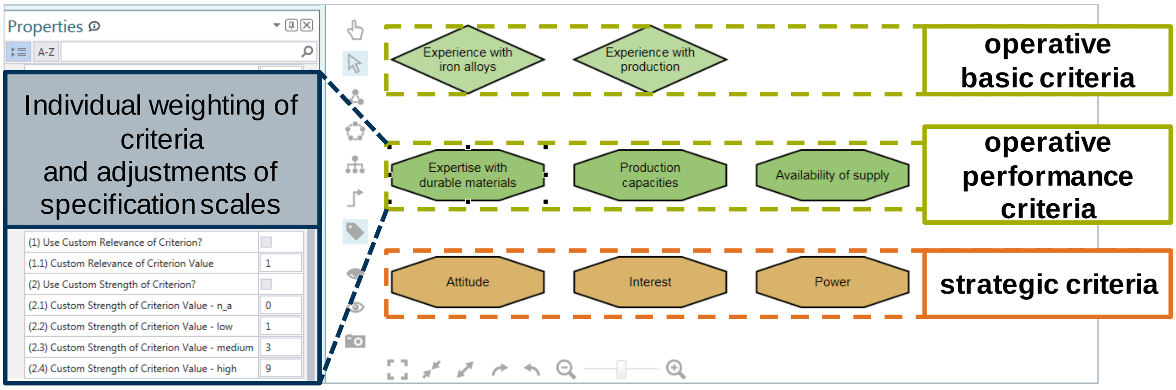


Figure 7-7: Graphical modelling of partner criteria within the software demonstrator

Identifying and analysing existing project stakeholders

Before searching for new potential OI partners, it is important to identify existing partners and stakeholders of a company. Along with creating an initial pool of potential OI partners, this reduces the risk of neglecting relevant stakeholders that might endanger the success of the OI project, for instance, because they have a strong negative interest or might feel neglected.

As shown in chapter 5.3, a systematic identification of stakeholders is a major challenge due to the lack of structured identification methods. A common method is paper-based brainstorming on a flip-chart, that strongly depends on the capabilities and expertise of the OI team. To support in particular inexperienced OI teams in SMEs, it is necessary to provide structured guidance. Therefore, an enhanced **stakeholder map** was developed and initially presented in GUERTLER et al. (2014c). It combines the features and strengths of different stakeholder identification approaches. The basis is a **graphical search** approach (cf. FREEMAN 1984, p. 6) since it is easier for humans to comprehend visual stakeholder networks and dependencies, and it also fosters discussions within the OI team. Based on this, different **search dimensions** (BALLEJOS AND MONTAGNA 2008, p. 285) and **search directions** (VRIES et al. 2003, p. 98) are adapted and integrated. In addition, the concept of a **process-based structure** was utilised (KAIN et al. 2009). These elements allow a systematic search by providing search directions and inherent guidance within these primarily rough directions. Figure 7-8 illustrates the stakeholder map. The template on the left side shows the major structure: a field of external stakeholders in the upper area, internal ones in the lower area, and a linking innovation process.

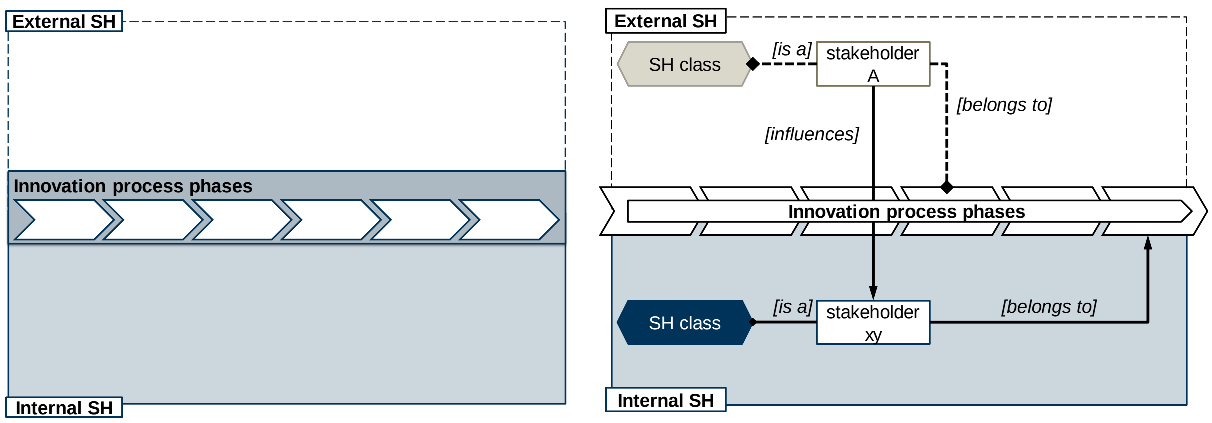


Figure 7-8: Stakeholder map (left: blank template; right: simplified meta-model)

When using the stakeholder map, the OI team starts with defining circa five generic innovation process phases. The process does not need to be comprehensive but should comprise the most relevant phases for the focussed innovation object or OI project. Its purpose is the provision of structure for the subsequent stakeholder identification. This means, in the following, external and internal stakeholders are identified that are linked to the single phases. To support the actual identification and limit the dependency of the OI team members' "creativity", lists of typical external and internal stakeholder classes derived from literature are provided, as shown in Table 7-9. (FREEMAN 1984, p. 25; HAUSCHILDT AND SALOMO 2007, p. 83; KARLSEN 2002, p. 21; KIRSCHNER 2012, p. 47) (also cf. chapter 2.3.2). The OI team can discuss the principal relevance of each stakeholder class for the OI project. When relevant the specific stakeholder class is included into the stakeholder map, otherwise it is not further considered. In addition, it is possible to modify suggested stakeholder classes or add new ones.

Table 7-9: Typical internal stakeholder classes

Class type	Stakeholder classes		
Internal stakeholder classes	employees	managers	entrepreneurs / owner families
	IT department	legal department	shareholders
	innovation management	quality management	controlling
	purchasing department	research and development	production
	sales department	service and maintenance	marketing
	internal customers	internal service providers	etc.
External stakeholder classes	customers (B2B / B2C)	users	suppliers
	retailer	cooperating companies	network partners
	industry associations	competitors	universities /research institutes
	media	social media groups	interest groups and activists
	consultants / service providers	insurances	consumer advocates
	legislator / norming organisation	certification authorities	residents / localities

After defining all relevant stakeholder classes, the OI team details each stakeholder class by using the defined process structure to identify **specific stakeholders**, for instance, all suppliers that are relevant in the product development and the production phase. Subsequently, influence dependencies between all stakeholders are analysed and inserted into the stakeholder map. Due to the effort and complexity, influence dependencies are generally defined as influence on the decision of another stakeholder, and are not further differentiated. Nevertheless, influence dependencies can be weighted regarding their strength as low, medium and high.

Identifying and modelling stakeholders in Soley

As illustrated in Figure 7-9, the software demonstrator provides pre-defined modelling elements and properties for modelling a stakeholder map, i.e. nodes for process phases, stakeholder classes and stakeholders as well as edges for linking stakeholders to process phases, stakeholders to stakeholder classes and for depicting influence dependencies between stakeholders. After modelling the main innovation process phases, the relevant stakeholder classes are arranged on a vertical line: external stakeholders above and internal ones below the process phases. Single stakeholders are located on a horizontal line with their corresponding stakeholder class and linked to them via “is a”-edges, which are necessary for the following analysis algorithms and can be hidden later for a better comprehensibility. In addition, each stakeholder is linked via “belongs to”-edges to specific process phases. It is also possible to model hierarchies of stakeholders by using “is a”-edges, e.g. different departments of a company with their specific employees. Finally, the influence dependencies between the stakeholders are modelled. The dependencies edges are directed and differentiated in terms of low, medium and high strength.

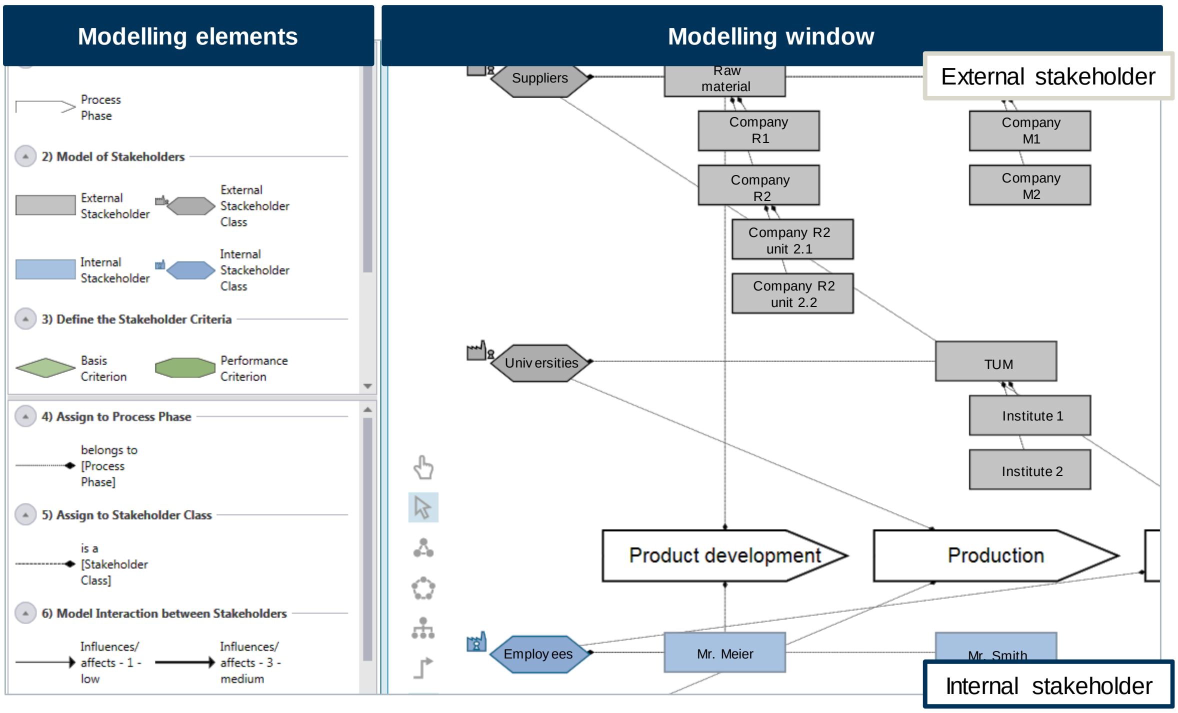


Figure 7-9: Modelling of stakeholders within the software demonstrator

7.3.2 Structuring stakeholders and initial assessment

The second step structures and initially assesses the known stakeholders to derive the specific delta between target and current state of potential OI partners. This indicates on the one hand either the pool of known potential OI partners is sufficient or there is the need of searching for new ones. On the other hand, it also supports in deriving promising search fields and directions.

Initial assessment of stakeholders and existing partners

Stakeholders are evaluated regarding the operative partner criteria by a step-wise approach to reduce the assessment effort, i.e. firstly basic criteria and secondly performance criteria. The latter are only evaluated for those stakeholders that fulfil all basic criteria. While basic criteria have a binary specification scale (*fulfilled*; *not fulfilled*), performance criteria have a four-step scale (*none*, *low*, *medium*, *high*). The regarding references need to be project-specifically defined in the previous step. Insufficient information about criteria should be documented by "*n/a*" (*not assessable*). When using a spreadsheet-based assessment form, the specifications should be split in textual (*n/a*, *low*, *medium*, *high*) and numeric ones (e.g. 0, *1*, *2*, *3*). This enables potential later changes of the numeric scale without touching the original assessment.

Initial assessment of stakeholders in Soley

Figure 7-10 shows the assessment in Soley. By running the workflow ***2.1 Evaluate Basic Criteria (Update Model)***, the tool opens a table view of all stakeholders and basic criteria, clustered according to the stakeholder classes. The assessment itself is conducted via selecting the specific specifications from a drop down list. By running the subsequent workflow ***2.2 Evaluate Performance Criteria***, stakeholders are greyed out, who do not fulfil all basic criteria. This increases the clarity of the stakeholder map. However, they are still analysed concerning their strategic relevance. When some criteria change over time, they can be adjusted. In this case, the workflow 2.1 also allows an **update of the entire model** and reactivates previously greyed stakeholders.

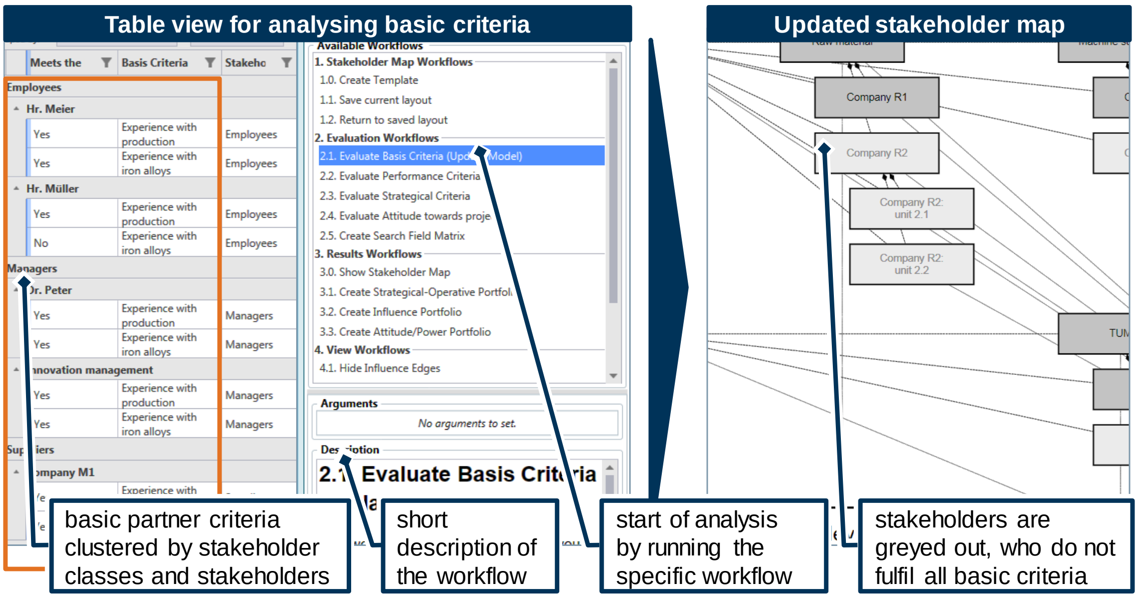


Figure 7-10: Initial assessment of stakeholders and accordingly updated stakeholder map

Structuring stakeholders and identification of search fields

The initially evaluated stakeholders are structured by a two-dimensional **search field matrix**, i.e. a simplified Domain Mapping Matrix (DANILOVIC AND BROWNING 2004; 2007). The x-axis holds the innovation process phases, while the y-axis depicts the operative performance criteria. The non-filtered stakeholders are assigned to the different fields according to their assessment results and phase links, as illustrated in Figure 7-11. Multiple field assignments are possible. This allows a systematic overview whether a sufficient pool of potential OI partners is already known or new additional ones need to be identified. In particular, for SMEs this delta analysis of target and current state of OI partners is important since their resources for an OI partner search are limited.

The underlying decision is indicated by the **decision gate G 2.1** (Figure 7-5) in the SOI methodology. When a **sufficient number of potential OI partners** is known, OI teams can proceed with the assessment in **step 4**. **Otherwise**, they should conduct the search **step 3**.

In addition, the search field matrix supports in deriving areas with a high number of stakeholders, and areas with no or only a low number of stakeholders. The latter indicate promising **search fields** for new potential OI partners. However, it is essential to discuss in particular these *white fields* with no stakeholders whether they are reasonable search fields or whether there are technical or other reasons for their emptiness. Depending on the specific OI project, it might also be reasonable to search within already full fields. For instance, cross-industry searches address the same field but focus on another industry sector. In this respect, it is principally possible to specify different ***search spaces*** within the search fields (cf. LOPEZ-VEGA et al. 2016, p. 126): (1) **local searches**, that are close to the original industry sector and problem area, show a low likeliness of finding OI partners for developing novel solutions but a higher chance of directly working ones. In contrast, (2) **distant searches** foster more radical solutions, that however are often not directly useable.

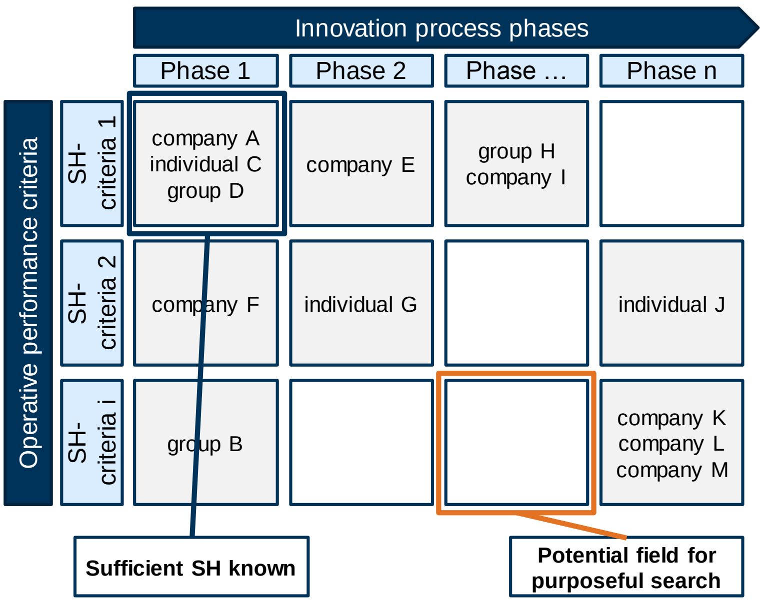


Figure 7-11: Structure of a search field matrix with highlighted "white fields"

The advantage of these search fields is a clear definition of alternative search spaces, which can be prioritised and delegated to different OI team members or student workers. This also allows parallel searches. In line with the previous step of the search methodology, it is important to document the selected search fields, and the reasons for a selection or exclusion of fields. Within the single fields, the specific search goal needs to be documented as it provides guidance for the subsequent search (e.g. "*identifying experts from other industry sectors who are experienced with steel-based lightweight constructions*").

Search field matrix in Soley

Figure 7-12 shows the search field matrix within the software demonstrator. Along with displaying the name of the stakeholders, their fulfilment level of the particular operative performance criteria is shown. This allows initial insights into the specific capabilities of stakeholders.

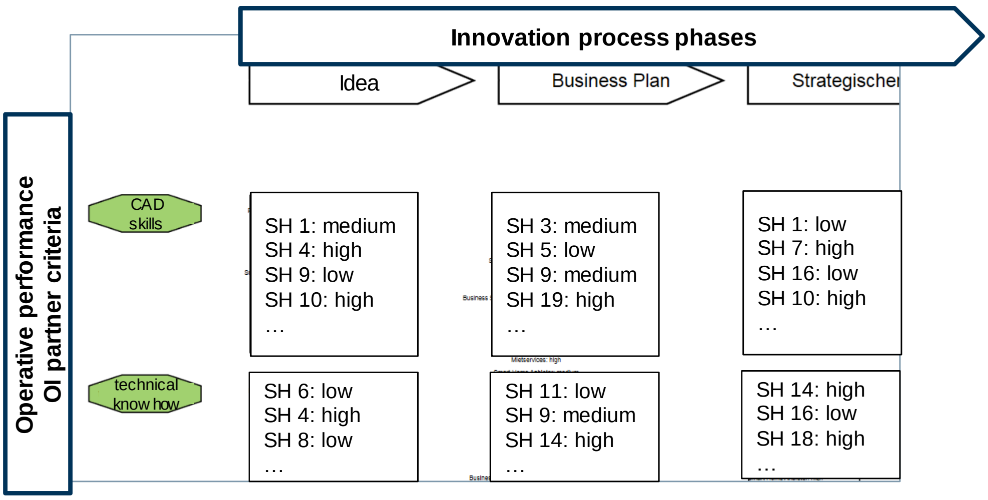


Figure 7-12: Search field matrix within the software demonstrator

7.3.3 Searching for new potential OI partners

This step searches for new potential OI partners, within the previously defined search fields. In this respect, it supports in selecting suitable search strategies and methods.

Selecting a suitable search strategy and search method

As illustrated in Figure 7-5, SOI differentiates two principal search strategies based on BOGERS AND WEST (2012, p. 68) and PHILLIPS (2011, p. 23): an **active search by the company** and a **self-selection by the OI partners,** following an open invitation of the company. The active search is particularly suitable when detailed knowledge and experience is required, radical innovations and useable IP shall be developed, and for OI projects with a high need of secrecy. The self-selection based search fosters a higher quantity and more diversified potential OI partners but usually attracts more public attention.

While SOI primarily considers broadcast searches for the self-selection based search, it comprises different search methods for the active search. The search methods are mainly derived from Lead-User identification (cf. chapter 5.3.2). They can be project-specifically enhanced by further search methods, for instance, patent database searches (cf. chapter 5.3.4). Hitherto, the following search methods are considered:

- **Media-based searching**: using keywords for searching within web-based search engines and databases (ECHTERHOFF 2014, p. 120f)
- **Screening** (HIPPEL et al. 2009): assessing an existing pool of potential OI partners concerning specifically defined partner criteria
- **Pyramiding** (HIPPEL et al. 2009): by using a snowball approach, potential OI partners are identified and asked if they know other persons who might have more expertise. These potential OI partners are then asked the same. (cf. VARVASOVSZKY AND BRUGHA 2000, p. 341)
- **Netnography** (BELZ AND BAUMBACH 2010): analysing a given community (e.g. users of a specific product) in respect to current discussion topics, needs, solutions and indications for outstanding users, who represent potential OI partners
- **Broadcast search** (ILI AND ALBERS 2010): by publishing a task on an internet-platform or via email, interested actors can develop and hand in solutions for this task. The self-selection process ensures that only motivated actors participate. Based on the quality of the submitted solutions, potential OI partners can be identified.

To support the selection of suitable search methods, the OI method profiles of SAUCKEN et al. (2015) were adapted (cf. GUERTLER et al. 2015b). Figure 7-13 illustrates the exemplary search method profile of pyramiding (all profiles in appendix 13.5). To give a first overview of the methods, the upper part describes the purpose, process, advantages and disadvantages of each search method. The lower part comprises different method's characteristics. This quantitative characterisation allows the comparison of two search methods.

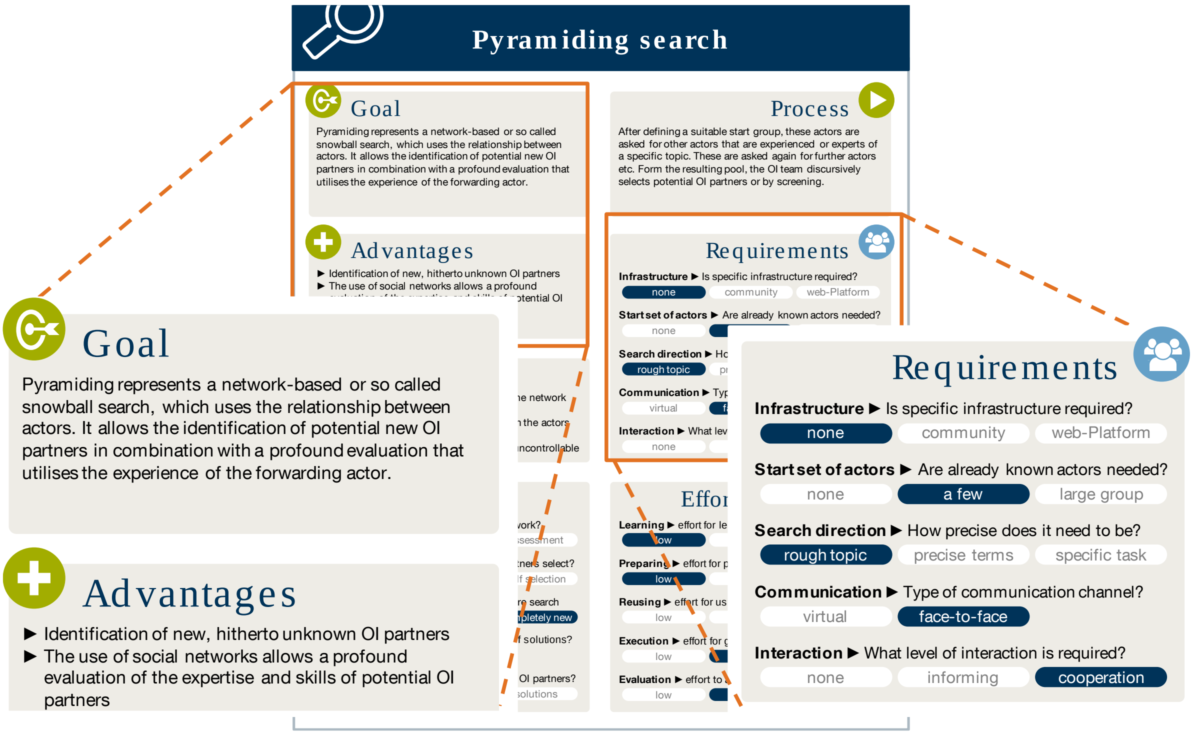


Figure 7-13: Exemplary search method profiles of Netnography and Pyramiding

In general, it is possible to adapt search methods when necessary. For instance, a pyramiding search can directly consult actors or, more indirectly, identify a first set of OI partners in the internet and analyse their websites or other media in respect to stated cooperations and partners. Along with this, search methods can be scaled in terms of search space (e.g. regional, national, international) and openness (e.g. pyramiding only in the context of a trade fair, or worldwide). In addition, different search methods can be combined. A common combination is an initial pyramiding search and a subsequent screening of the gained pool of potential OI partners.

7.3.4 Assessing potential OI partners

Based on the results of the initial assessment in the second step, this step assesses known and optionally newly identified potential OI partners concerning their operative and strategic relevance to the OI project.

Assessment procedure

Analogously to the initial assessment, the evaluation of **operative partner criteria** is based on a stepwise approach, starting with **basic criteria** to rate the principal suitability for the OI project, and filtering all potential OI partners, who do not completely fulfil them. The remaining ones are assessed concerning the **performance criteria** for a differentiated evaluation of their capabilities and a subsequent ranking. The fulfilment of **excitement criteria** can support the decision between equally ranked potential OI partners. The necessary assessment information can be based on the experience of the OI team's members, investigations on websites of potential OI partners, databases and social media, and by interviewing trusted external partners. The existing assessment from the first step can directly be used but should be evaluated concerning potential changed of OI partner criteria in the meantime.

Strategic partner criteria are assessed for all stakeholders and new potential OI partners, independently from their operative capabilities. This is important, in order to identify actors and dependencies that are relevant for the success of the OI project. Along with identifying the most powerful supporters and opponents of the OI projects, it also reveals critical dependencies between powerful opponents and favoured OI partners. Due to the modular setup of the OI partner search methodology, the strategic evaluation can also already be conducted in parallel to the initial assessment in the second step.

In general, access to reliable information for the assessment is a major challenge as well as individual biases. Therefore, it is essential to conduct and discuss the assessment within the OI team. If necessary, additional experts can be involved for specific assessment aspects.

The **decision gate G 2.2** (Figure 7-5) indicates the evaluation if the number of potential OI partners is sufficient that fulfil all operative basic criteria. The required minimum number is project-specific and depends, for instance, on the project's goal. In the case of an **insufficient number of potential OI partners**, the **search step 3 should be repeated** by using the defined search field matrix from step 2. **Otherwise**, the OI team can **proceed with step 5**.

Within the software demonstrator, the assessment of these criteria is realised similarly to the assessment of the basic criteria, as illustrated in Figure 7-11.

7.3.5 Ranking and selecting Open Innovation partners

Based on the assessment results, this step ranks potential OI partners in respect to their relevance to the OI project. The methodology comprises different ranking perspectives to provide support in diverse project situations. This serves as basis for selecting relevant OI partners and general involvement paths, which are specified in the following step. In general, the interdependencies between the selection of OI partners and involvement paths is close. The implementation of these ranking perspectives in different portfolios allows the consideration of different selection dimensions but also avoids to overwhelm the OI team by one overloaded ranking. The following three portfolios derive the basis of a discursive selection of OI partners within the OI team.

The basic tool is the **Strategic-Operative Portfolio**, which was originally presented in GUERTLER (2014). As illustrated in Figure 7-14, potential OI partners are ranked in respect to their **operative-technical potential** on the x-axis and their **strategic relevance** on the y-axis. Both dimensions are normalised weighted sums of all operative, respectively strategic OI partner criteria. Stakeholders with a positive supportive attitude towards the OI project are depicted as white circles, negative opponents as dark circles.

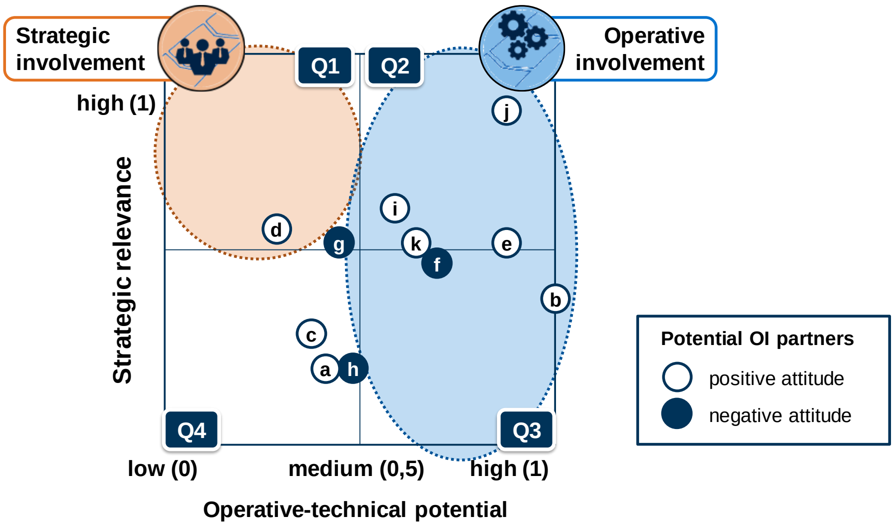


Figure 7-14: Strategic-Operative Portfolio

In general, stakeholders are more qualified for operatively contributing to a solution, the more on the right they are located. The more to the upper border of the portfolio, the higher is the strategic relevance to the success of the OI project. This allows to define four qualitative[28] quadrants (Q) of generic involvement paths: stakeholders in **Q2** represent primary OI partners due to their high operative qualification and high strategic relevance. **Q3** comprises potential OI partners that are not directly important for the strategic success of the OI project but are promising for developing a solution of the OI project, for instance, experts from other industries. Depending on the OI project's objectives, they can enhance OI partner teams from Q2 or represent the main team, for instance, in the context of cross-industry innovation projects.

[28] This means, the borderlines between the quadrants are not fix and vary for each OI project. Their purpose is to provide guidance for evaluating potential OI partners but not to take the selection decision.

Due to their low technical qualification, stakeholders in **Q1** should not be operatively involved in the OI project. Nevertheless, their high influence on the success of the OI project requires a sufficient strategic involvement. Stakeholders in **Q4** can be widely neglected due to their low technical qualifications and low strategic relevance. Nevertheless, their position in the portfolio should be evaluated by the OI team to prevent analysis errors.

The second portfolio for ranking potential OI partners is the **Attitude Influence Portfolio** (BRYSON 2004, p. 39). As shown on the left side in Figure 7-15, it structures stakeholders according to their influence on the x-axis and to their attitude and interest on the y-axis. In this respect, **influence** describes the power of affecting the decisions of other stakeholders. The **attitude** distinguishes between supporters and opponents of the OI project. The intensity of their specific attitude is indicated by the strength of their **interest** in the OI project. Stakeholders in the upper right corner are particularly relevant since they represent powerful and interested supporters of the OI project, while the lower right corner comprises the most powerful and dedicated opponents. While the first group should be involved (e.g. as promotors), the second group should be defended by appropriate preventive measures.

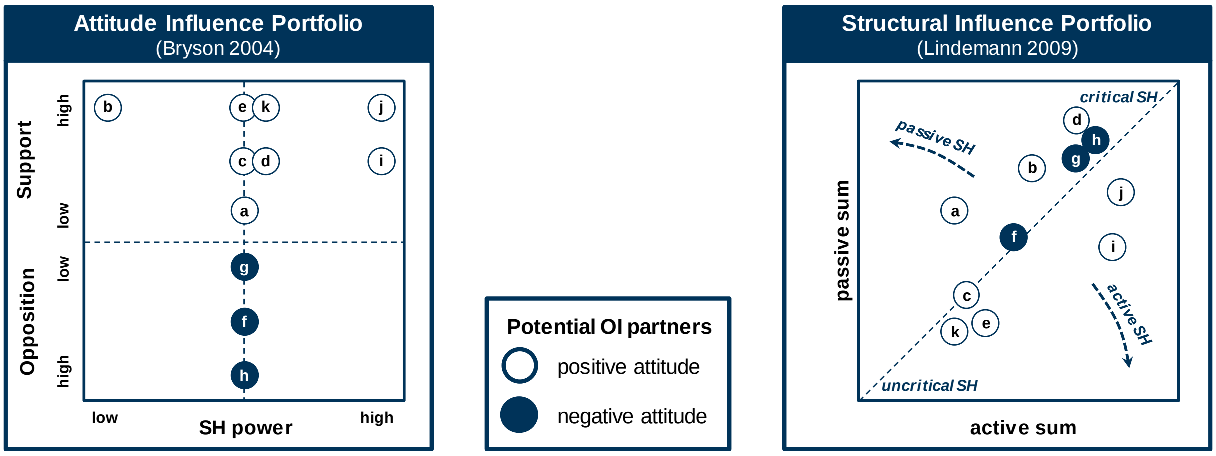


Figure 7-15: Attitude Influence Portfolio and Structural Influence Portfolio

The **Structural Influence Portfolio** ranks stakeholders due to their dependency-based influence within the stakeholder network, as illustrated on the right side in Figure 7-15 (based on: LINDEMANN 2009, p. 76f). The **active sum** on the x-axis indicates the number of other stakeholders that are influenced by a focal stakeholder. In contrast, the **passive sum** on the y-axis is a measure for the number of stakeholders that influence a focal stakeholder. Depending on the specific OI project, dependencies can be weighted according to their strengths, which allows a more diversified ranking. The **activity** metric, as quotient of active and passive sum, indicates if a stakeholder has a more active or passive role within the network. The **criticality** metric, as product of active and passive sum, is a measure of the connectivity of a stakeholder. Due to their high effect on other stakeholders, active stakeholders are particularly relevant for the OI project. Furthermore, critical stakeholders are also relevant due to their strong interrelationships to other stakeholders. For instance, supportive ones can be involved as promotors, while opponents should be monitored or "defended" sufficiently. This categorisation is in line with the ***influence impact portfolio*** of (GAUSEMEIER et al. 2012, p. 4), who cluster their stakeholders in six categories and involvement strategies.

The **decision gate G 2.3** (Figure 7-5) indicates that OI teams have to **evaluate if all relevant project tasks or roles are sufficiently occupied** with operative and strategic OI partners. **Otherwise**, OI teams should purposefully repeat the **search step 3** by using the defined search field matrix. This evaluation is usually part of step 5 as well as of step 6 due to the strong interrelationship of both steps.

Multi-perspective ranking potential OI partners in Soley

Figure 7-16 shows the three portfolios within the software demonstrator. By using the respective workflows, the tool user can switch between them. In addition, it is possible to interactively hide and show the dependency edges between stakeholders to increase clarity of the portfolios and support the discussion in the OI team.

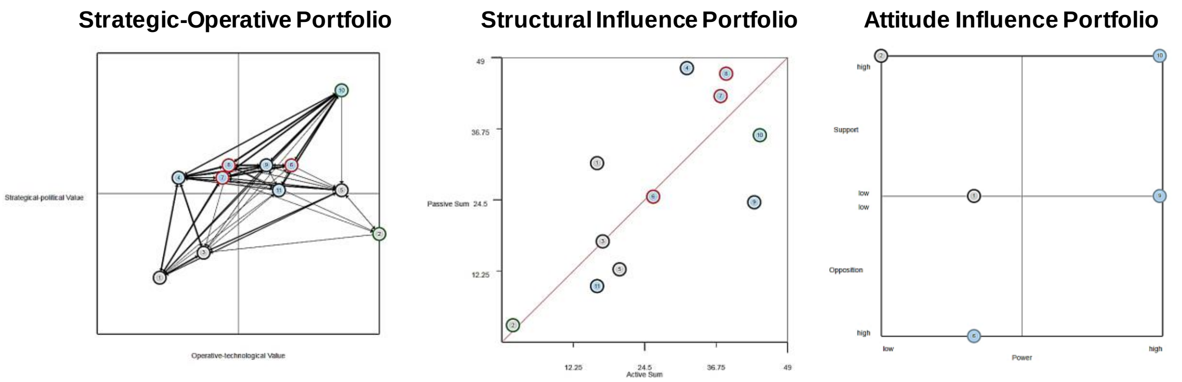


Figure 7-16: Multi-perspective ranking potential OI partners

7.3.6 Developing cooperation strategies

Based on the principal involvement paths from the previous step, this step further concretises the specific type of involvement as well as measures to deal with critical stakeholder dependencies.

Identifying and dealing with critical stakeholder dependencies

The previous step supported in deriving a prioritised list of potential OI partners along with principal involvement paths: an operative and a strategic involvement. However, to ensure the success of an OI project and reduce the risk of subsequent collaboration barriers and threats, it is important to consider also the **dependencies between stakeholders**. They are depicted as directed edges within the portfolio. While dependencies originating from positive stakeholders can have a positive effect onto the attitude of others, dependencies from opponent stakeholders are a potential threat as they can negatively affect other stakeholders. Figure 7-17 illustrates the exemplary portfolio from an industry project: while 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 opponent (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 be a threat for the success of the OI project.

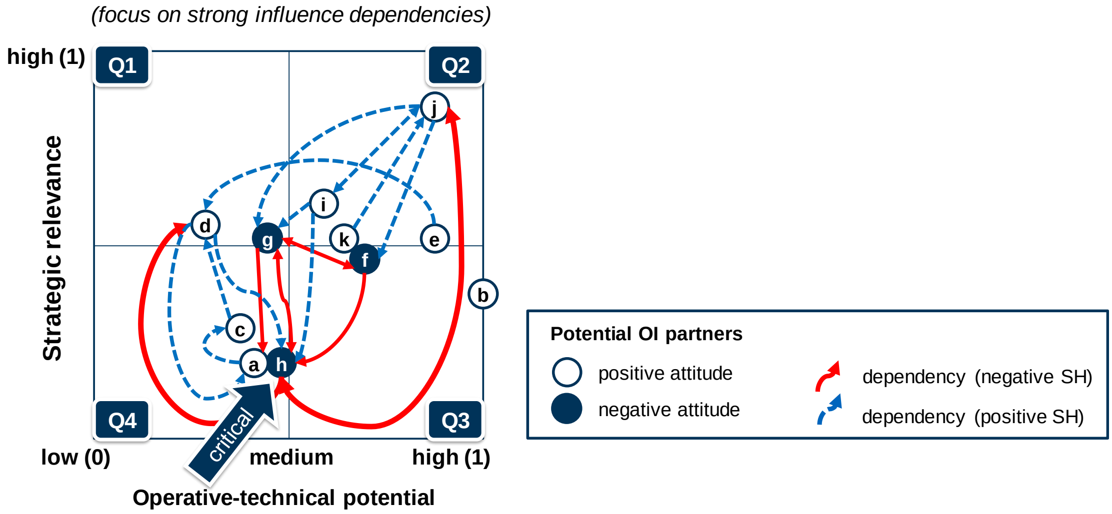


Figure 7-17: Strategic-Operative Portfolio with strong influence dependencies

There are four principal measures for dealing with these dependencies. The Attitude Interest Portfolio and the Structural Influence Portfolio support in deriving the most appropriate one.

1. **Involving (j) but continuously monitoring**

   If (j) is essential for operatively solving the problem of the OI project and also has a strong positive attitude, it can be possible to still involve him. In this case, (h) must not be a strong and powerful opponent. Nevertheless, an intensive monitoring of both stakeholders and their dependency is essential to timely identify potential behavioural changes and resulting risks.

2. **Convincing and involving the negative stakeholder (h)**

   Convincing a negative stakeholder and involving him as a supporter is promising if his original negative attitude is not too strong. In particular, critical and active stakeholders are advantageous to be involved. Enablers for this measure can be powerful positive stakeholders that have a strong influence dependency onto the negative stakeholder.

3. **Cutting the dependency between both stakeholders (h) and (j)**

   It is particularly applicable with weak and medium dependencies between two stakeholders. The stronger the dependency or if being bidirectional, the less promising it is.

4. **Excluding the favoured stakeholder (j)**

   In the case of a strong negative attitude of (h) and a strong bidirectional dependency between both stakeholders, it can be necessary to exclude the favoured (j). In particular, if (j) has only a low positive attitude, the risk of a negative influence from (h) is high.

However, in any case it is crucial to discuss and select each measure within the OI team. This allows the consideration of often implicit information and circumstances, which might only apply for this particular company and situation.

When all potential risks are evaluated, in the following, the involvement paths are detailed for the favoured OI partners.

Operative involvement for solving the OI project's problem

The specific planning of the operative involvement of OI partners is addressed in the following chapter of SOI 3. This presents the corresponding methodology and its implementation as Excel demonstrator.

Strategic involvements to ensure the success of the Open Innovation project

The strategic involvement of OI partners can be differentiated according to BRYSON (2004, p. 32f) and MACARTHUR (1997, p. 255) in the following measures, as shown in Table 7-10.

Table 7-10: Strategic involvement measures

Measure	***Description***
Inform	The OI partner is regularly provided with information of the project's progress.
Consult	The OI partner is frequently informed and provides feedback, which is considered by the OI team.
Participate (originally: involve)	The OI partner is irregularly involvement in OI team meetings and can provide feedback, which the OI team tries to incorporate.
Collaborate	The OI partner is regularly involved in OI team meetings and his feedback is incorporated to a maximum extend.
Empower	The OI partner is involved as decision maker and the OI team implements his decisions.

To efficiently plan and document the strategic involvement, these measures are integrated in the ***strategic involvement planning matrix***, as shown in Figure 7-18 (adapted from: BRYSON 2004, p. 33). On y-axis, project-specifically defined project phases are applied. The matrix shows exemplary phases from PMI (2013, p. 49). The purpose of this matrix is to **structure, plan and schedule the specific involvement** of the selected OI partners. For instance, the manager of the particular business unit hosting the OI project is *empowered* as decision maker when initially defining the scope and goal of the OI project, and subsequently *informed* about the OI project's progress as power promotor by specifically created management summaries.

Project phases	**Inform**	**Consult**	**Participate**	**Collaborate**	**Empower**
Initiating phase					**manager BU** (*decision maker*)
Planning phase					
Execution phase	**manager BU** (*power promotor*)				
Monitoring and controlling					
etc.					

Figure 7-18: Strategic involvement planning matrix (based on: BRYSON 2004, p. 33)

As the selection of these ways of strategic involvement are highly depending on the specific company and project situation, the Attitude Influence Portfolio and Structural Influence Portfolio can provide indications of whom to involve and in which way, but the specific way needs to be **discursively selected within the OI team**. This allows the consideration of the multitude of possible implicit influencing factors.

Project roles

As indicated in Figure 7-18, it is also recommended to assign specific project roles to each OI partner. OI project roles comprise specific tasks, responsibilities and behavioural patterns in the OI project (cf. chapter 5.3.3). Table 7-11 shows common project roles derived from stakeholder analysis. Favoured OI partners can be assigned to appropriate roles by the OI team. To allow a structured assignment process, a Domain Mapping Matrix (DMM) (DANILOVIC AND BROWNING 2007) can be used for mapping OI partners and roles. By summing up all cell entries of a row and a column, unfulfilled project roles as well as OI partners without a role can be identified. This ensures that all relevant project roles, i.e. tasks and responsibilities, are fulfilled and all involved OI partners contribute a specific benefit to the OI project. In this respect, the role of *negatives* itself is not desirable but supports in reflecting – based on the results from the previous portfolios – who are the most critical opponents of the OI project. Since one OI partner can fulfil several roles and one role can be fulfilled by several OI partners, it is possible to derive alternative involvement scenarios. Finally, the involved OI partners and their specific roles are **documented in the strategic involvement planning matrix**.

Table 7-11: Project roles (BALLEJOS AND MONTAGNA 2008, p. 285; VOS AND ACHTERKAMP 2004, p. 10)

Project roles	**Description**
Beneficiaries / clients	They benefit from the innovation object (usually products) and the project. The benefit can be further differentiated into functional and financial benefits. Political beneficiaries benefit indirectly by increased power, influence or prestige.
Sponsors	They provide or organise sufficient funding for the project and protect the budget against reductions.
Promotors	Detailed description see subsequent section.
Negatives / opponents	They oppose the project since they are negatively affected by the project or its outcomes (e.g. by losing their jobs, losing power for decision making, physical damage, financial damages, etc.)
Responsible	They are responsible project and its outcomes, including budgets, schedules and the fulfilment of technical and organisational requirements.
Decision-makers	They control the project and process, and make decisions to reach the defined project goal.
Regulators / legislators	They define regulations and guidelines to control and assure the quality, security, costs and other aspects of the project and its outcome.
Operators / users	They use or operate the innovation object that is developed or improved by the project. They are similar to functional beneficiaries but do not automatically benefit from using the innovation object.
Experts	They are familiar with specific aspects of the project and the innovation object. Their expertise can be used to operatively solve particular problems and tasks.
Consultants	Similar to experts, they provide support for the project but often focus on organisational and administrative aspects.
Developers / designer	They are primarily involved in developing the innovation object of the project and have experience and expertise from similar and previous development projects.
Passively involved	They are affected by the project's outcomes but are not able to influence it.

A special group of role are the so called promotors that represent specific supporters of an OI project. OI projects as a novel type of innovation project needs particular strategic support in the company (GASSMANN AND SUTTER 2008, p. 6). In particular, stakeholders with a high influence and activity are suitable for an involvement as **power promotor**, who ensures the supply of sufficient resources and support of employees. **Technology promotors** are experienced employees, who can *participate*, respectively be involved for support in specific technical questions (cf. HAUSCHILDT AND KIRCHMANN 2001, p. 42). **Process promotors** help to overcome administrative and bureaucratic barriers, and company-internally advertise the OI project. Therefore, they are usually highly connected and influential internal stakeholders. **Relationship promotors** (or also: *gatekeepers* (ILI et al. 2010, p. 253; PARIDA AND JOHANSSON 2009, p. 445)) are the quasi-external pendant as they foster and manage relationships between internal and external stakeholders (ALBERS et al. 2014b; GEMÜNDEN AND WALTER 1996). Hence, they should have good connections to both groups of stakeholders.

All involved OI partners, their type of involvement, underlying reasons and optionally their OI project role has to be documented to allow the traceability of the planning process and decisions. The explicit definition and documentation of "**backup**" OI partners ensure a fast reaction if there occur problems with primarily favoured OI partners. The use of OI partner profiles (BALLEJOS AND MONTAGNA 2008, p. 287), allow a structured documentation.

7.3.7 Control questions to evaluate the planning progress

The following control questions in Table 7-12 support the OI team in reflecting the planning progress in terms of completeness and considering the most relevant outcomes of this phase. This provides guidance and orientation within the planning process.

Table 7-12: Control questions to evaluate the selection of OI partners

Aspect	***Questions***
Evaluation of the OI partners selection	• Which competences, skills and resources of the potential OI partners are essential to operatively develop a solution in the OI project? Which ones are optional? • Have an operative as well as a strategic perspective been considered? • Have potential differences between customers (buyers) and users of the product been considered? • Have external and internal stakeholders been considered as potential OI partners? • Have stakeholders along the entire innovation process and product life cycle been considered? • Are there critical dependencies between favoured OI partners and opponents? • Who are the most powerful opponents and supporters of the OI project? Are they sufficiently involved into the OI project? • Do the favoured OI partners fit the company's PR reputation? For instance, it might be problematic if eco-focussed company collaborates with an oil company. • Are some of the OI partners mutual competitors, which might result in a limited collaboration due to restraining knowledge? • Is a sufficient number of "backup" OI partners defined that can be acquired when the favoured OI partners do not collaborate sufficiently? • Is a date defined when the stakeholder analysis and the assessment of the most relevant OI partners is evaluated again to capture potential dynamic changes? • Are all results, intermediate results and decisions documented?

7.4 SOI-3 – Open Innovation methods selection

This chapter presents the approach for selecting suitable OI methods based on the results of the OI situation analysis and the pre-selected OI partners. Due to the strong interdependency of OI partners and appropriate OI methods, the selection approach also supports in deriving the most suitable OI partner-method combination for a given OI situation. This can mean that, for instance, the first-ranked group of OI partners is neglected in favour of the second- or third-ranked ones in the end.

7.4.1 Structuring OI methods by method profiles

As explained in chapter 5.4, the basis of a systematic OI method selection is an appropriate characterisation and structuring of OI methods. Since there is the lack of a sufficient method model, it is necessary to develop an OI-specific one. In close cooperation with the author of this dissertation, SAUCKEN et al. (2015) developed a specific method model for OI methods, based on the general method models presented in chapter 5.4.1. In the context of two academic expert workshops, method characteristics and specification scales were derived and evaluated. The underlying requirements of the method model and characteristics were: **manageability** (as few characteristics as possible, but as many as necessary), **distinction** (of OI methods by their characteristics), **comprehensibility** (of characteristics and specifications), and **unambiguity** (reproducible and clear characterisation of OI methods).

Figure 7-19 illustrates the developed OI method model. It can be structured in two areas: a (1) **descriptive header** section, comprising the goal, process, advantages and disadvantages, gives an overview of the specific OI method. The (2) **method profile** section quantitatively specifies the OI method by defined characteristics and distinctive specification scales. The latter is the basis of the following OI method selection approach and its software implementation. The method profile can be sub-clustered in characteristics specifying the **OI partners** that can be involved by the OI method, the **task settings** that can be solved by using the OI method, and the **effort** of preparing, executing and reusing the OI method.

In total, the following 12 OI methods are considered for the selection approach in the next chapter: (1) ideation contest, (2) ideation platform, (3) problem broadcasting, (4) community for OI, (5) netnography, (6) Lead-User approach, (7) Immersive Product Improvement (IPI), (8) toolkits for user innovation (early phases), (9) toolkits for user co-design (late phases), (10) cross-industry innovation (CII) approach, (11) University cooperation, and (12) OI intermediary. A detailed description of each OI method is presented in chapter 2.3.3. All corresponding method profiles can be found in the appendix (chapter 13.5).

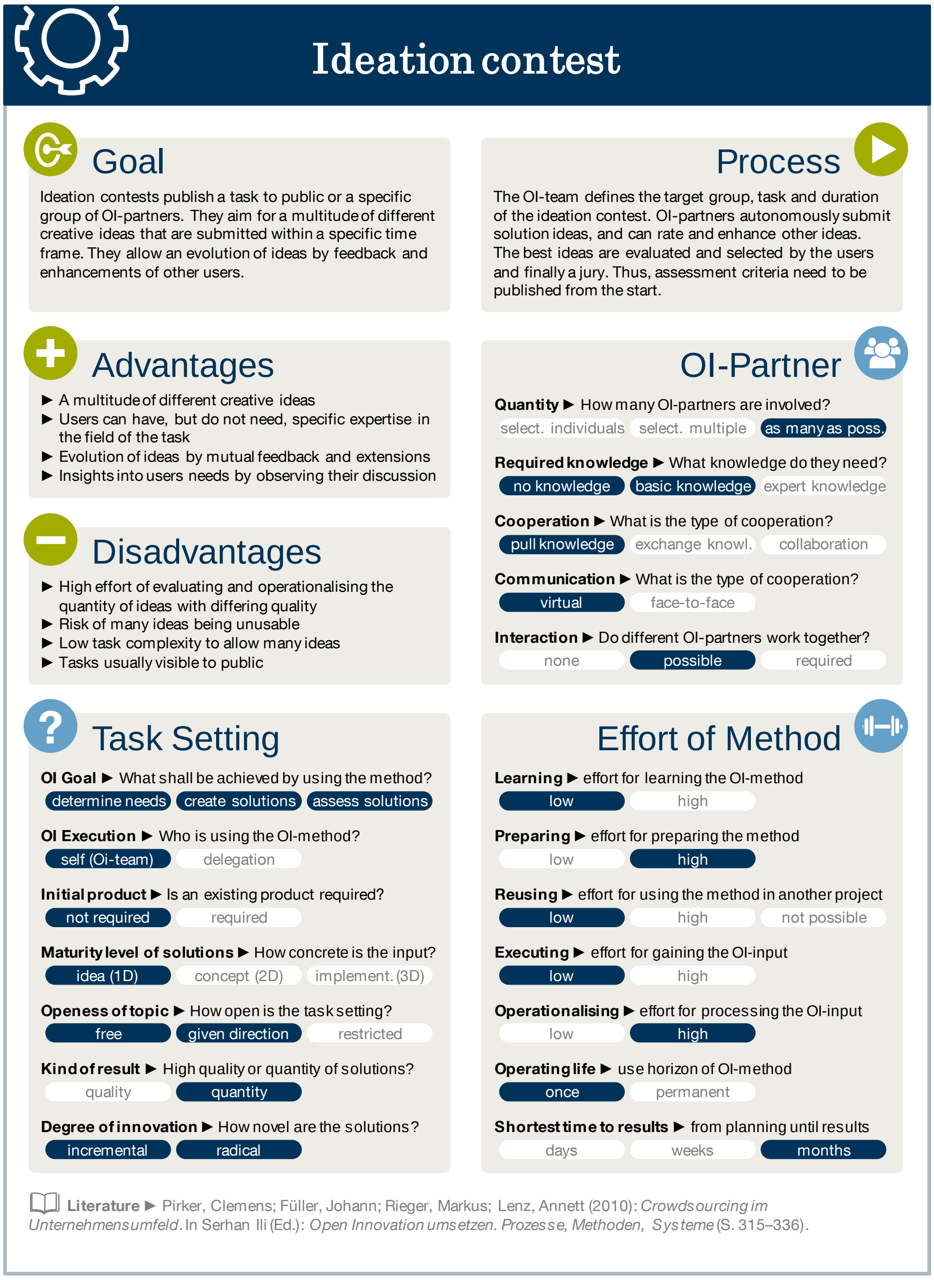


Figure 7-19: OI method model and profile of an ideation contest

7.4.2 Selection support of suitable OI methods

To fulfil the requirements derived in chapter 4.4, a matrix-based approach is applied, which decouples OI method characteristics from selection criteria, i.e. OI situation and OI partners criteria. This allows a differentiated consideration of OI situation and OI partners and solves the challenge that their criteria are usually not identical with the characteristics of the OI methods. In addition, criteria respectively characteristics can be added in the future. Along with this, the matrix approach also ensures a future enhancement by further OI methods. An initial version of the OI method selection approach was presented in GUERTLER et al. (2015a), based on PE: TESCH (2015).

Basic structure

Figure 7-20 illustrates the basic structure of the OI method selection approach, which is explained in more detail in the following sections. The core elements are two DMMs, which map criteria of the OI situation and favoured OI partners onto the characteristics of the OI method model. Along with a general link, this also specifies a positive or negative dependency, for instance, a limited timeframe of the OI project has a negative dependency to OI methods with a high effort of preparation and execution.

The input of OI situation and favoured OI partners in the selection approach is realised as vectors. The specifications of all criteria of the OI situation respectively OI partners are aligned as column vector. As the specification of a criterion can only have binary values, the partial vector of ***customer access*** (*direct; indirect*) with direct access would be $[1; 0]^T$. The partial vectors of the other criteria are accordingly located above or below. Analogously, the OI method profiles are also stored as vectors. This allows, a matrix-multiplication of the input vectors with the DMMs. The resulting intermediate vectors are multiplied with the vectors of all OI method profiles. The resulting scalar products represent the suitability scores of each OI method - differentiated in suitability for the OI situation and the favoured OI partners.

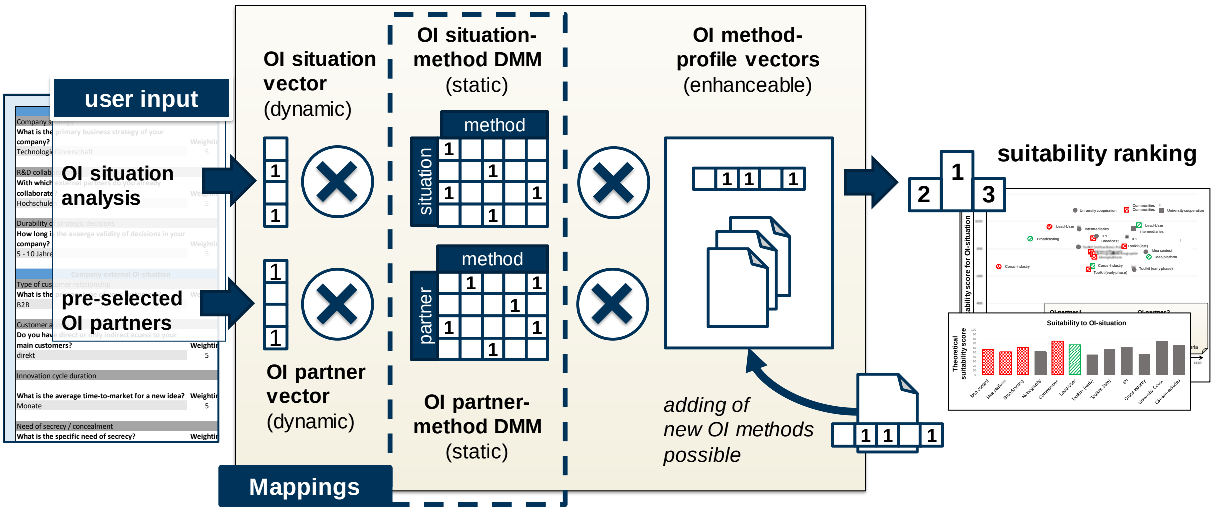


Figure 7-20: Basic structure of the OI method selection method (based on: GUERTLER et al. 2015a, p. 8)

Along with the OI situation criteria in chapter 7.2.2 whose specifications are analysed in the OI situation analysis (SOI 1), Table 7-13 show the OI partner criteria, which are considered within the selection approach. The majority of the OI partners' specification is analysed in the context of the OI partner search (SOI 2) and can directly be transferred. Some criteria's specification still need to be assessed for the favoured OI partners as it is not reasonable to assess them for all potential OI partners.

Table 7-13: OI partner criteria considered within the OI method selection approach (GUERTLER et al. 2015a, p. 9)

Criterion	Description	Specification scale
General criteria		
Affiliation to company	How is the potential OI partner affiliated to the company?	department-internal; company-internal; network-internal; external
Size of OI partner	What is the size of the favoured OI partner/s?	individual; group; crowd
Locality	Where is the OI partner geographically located?	same place; same region; same country; same continent; international
Strategic criteria		
Interest in product / project	What interest does the favoured OI partner have in the product or the OI project?	none; low; medium; high
Attitude to product / project	What attitude does the favoured OI partner have towards the product or the OI project?	positive; neutral; negative
Type of OI partner	Is the favoured OI partner a company or a private actor?	B2B; B2C
Cooperative capabilities	How is the OI partners capability to cooperate with the company or other OI partners?	none; low; medium; high
Influence on product / project	Which influence does the favoured OI partner have onto the product or the OI project?	none; low; medium; high
Operative criteria		
Product experience	How familiar is the favoured OI partner with the product (innovation object)?	no experience; occasional use; regular use; expert user
Knowledge maturity	Which level of knowledge maturity is expected from the favoured OI partner?	needs; solution ideas; solution concepts; prototypes; feedback
Capabilities of abstraction	How capable is the favoured OI partner to structure and solve the given problem on an abstract level?	low; medium; high

Development of the OI situation-partner-method DMMs

This section gives an overview of the structure and the development of the DMMs as central part of the OI method selection approach. The DMMs were developed in a three-step process. In the first step, the list of considered OI situation and OI partner criteria was developed in an academic team of five members. Criteria with no direct links to OI methods were filtered, such as a company's organigram or annual expenses for R&D.

In the second step, each team member autonomously rated the logical dependency between the pre-filtered criteria and the OI method's characteristics on a four-step scale (*0: no link, 1: weak, 2: medium, 3: strong link*). By summing up all partial values, a total scale from zero to 15 was derived, as illustrated in Figure 7-21. Assuming that relevant links should have a medium strength in average, the resulting minimum mapping value is 10. Nevertheless, for validation reasons also links with mapping values of eight and nine were considered for the following step (i.e. the majority of the team (three of five) had rated a medium strong link).

In the third step, all links with a minimum value of eight were analysed in more detail, i.e. on a specification level. While the previous step just evaluated the existence of a general dependency between OI situation respectively OI partners' criteria and OI method characteristics, this step analysed the particular positive or negative effect of criteria specifications onto characteristics specifications. Three members of the academic team autonomously evaluated the according mapping values on a three-step scale (*from "-1" = negative correlation, via "0" = no correlation, to "+1" = positive correlation*). Subsequently, differing partial results of these single evaluations were discussed in the team and a common mapping value derived, as illustrated in Figure 7-21.

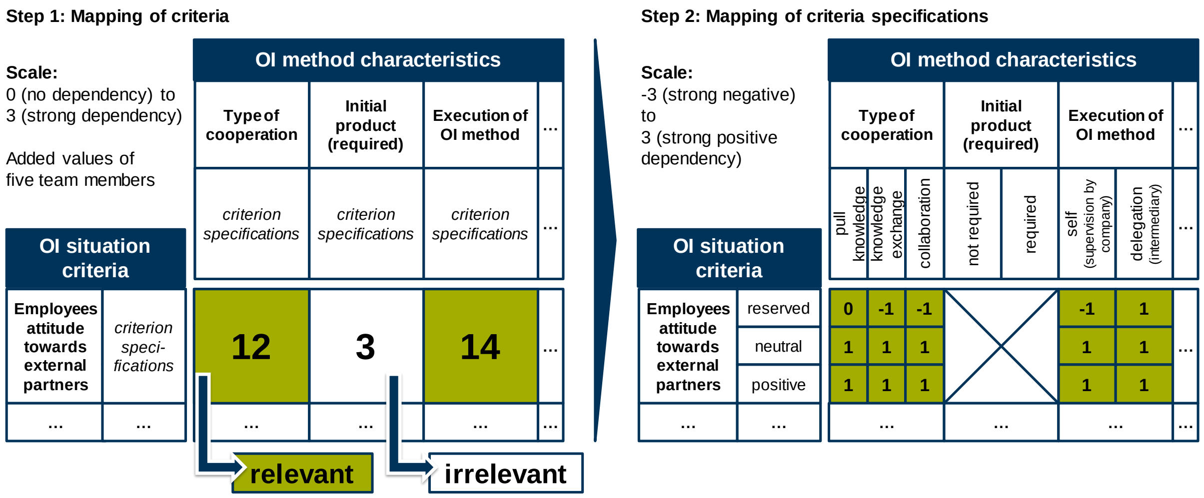


Figure 7-21: Stepwise development of the OI situation-method DMM (based on: GUERTLER et al. 2015a, p. 9)

Based on the results of an initial evaluation in industry (cf. GUERTLER et al. 2015a), the DMMs were slightly modified. To avoid ranking biases due to differing numbers of links between criteria and characteristics, multiple choice options of specifications were replaced by single choice options. This means for instance, instead of specifying two parallel company strategies, the most relevant has to be chosen now. In addition, each method characteristic was normalised by the number of incoming specification edges to avoid structural biases.

Along with this, for each OI method a reference score was added, which uses an input vector that comprises only entries of "1". The final ranking score of each OI method is derived as delta between this reference score and the "raw" score of the matrix multiplication of the actual input vectors. This means, the reference score is used to calibrate the final ranking scores of each method and compensates the effect of varying numbers of links in the method models (e.g. cross-industry cooperations have an entry-sum of 21, while ideation contests have 24). Negative final ranking scores indicate unsuitable OI methods.

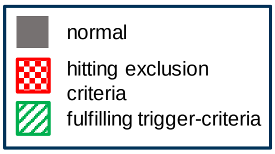
Trigger criteria and criteria of exclusion

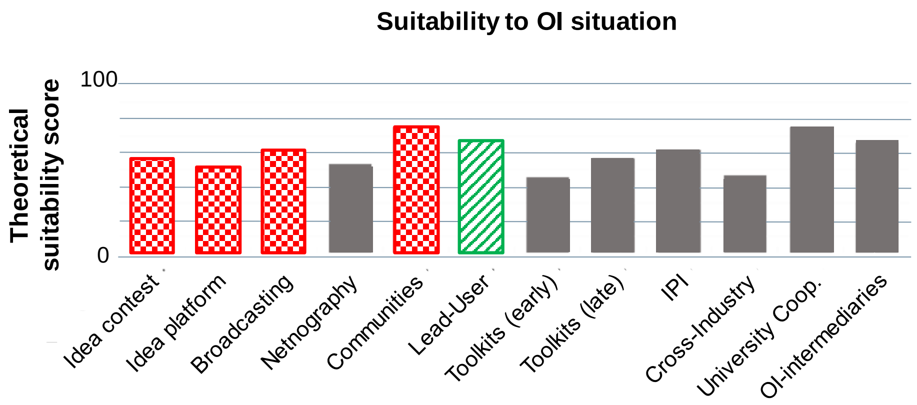
Along with the DMMs, OI method-specific trigger criteria and criteria of exclusion were identified. In this respect, **trigger criteria** are indicators for a particular OI method, while **criteria of exclusion** (German: "*KO-Kriterien*") are contra-indicators. Nevertheless, they do not cause an automated selection or exclusion of OI methods. Instead they point out to the OI team that there are specific reasons for or against particular OI methods. In the following, the **OI team needs to evaluate these indicators**. In the case of criteria of exclusion, this can reveal the specific need of adapting the OI method, or in the worst case, the exclusion of this OI method. To avoid biases, these criteria are not considered within the ranking score.

For identifying these criteria, the five members of the academic team autonomously evaluated all OI situation and OI partner criteria using blank versions of the two DMMs. If criteria specifications are triggering specific OI method characteristics, this was indicated by a "+1" entry. For instance, the OI partner size *crowd* is triggering OI methods that focus on crowds. Criteria of exclusion were marked by "-1" entries. In the subsequent team discussion, criteria were fixed, if three or more team members agreed. In the case of two, it was discussed within the team. In the case of only one, the criterion was dropped. In this respect, the general team rating was consistent since no criterion was rated as trigger or exclusion criterion at the same time.

Suitability rankings of Open Innovation methods

To support a profound selection of suitable OI methods, the selection approach uses two ways of presenting the ranking scores of each OI method. The first way is a one-dimensional bar chart in combination with a ranked list, as illustrated in Figure 7-22. The higher the bar, the higher is the specific suitability to the OI situation. In addition, OI methods fulfilling one or more trigger criteria are highlighted in green (striped). The fulfilment of criteria for exclusion is highlighted in red (checked). When both criteria apply to an OI method, the criteria for exclusion dominates. Along with a bar chart considering solely the suitability to the OI situation, there are also alternative bar charts comprising the summed scores of OI situation and specific OI partners to allow an aggregated view. As explained in the following section, the software demonstrator also provides a detailed overview of all these criteria for all OI methods.





Score	OI method
1085	Communities for OI
1083	University cooperation
963	Lead User approach
948	OI intermediaries
887	IPI
874	Broadcasting
813	Toolkit (late phase)
782	Idea contest
767	Netnography
738	Idea platform
670	Cross-Industry
653	Toolkit (early phase)

Figure 7-22: One-dimensional ranking in respect to the OI situation

The other ranking method is a portfolio, which allows a two-dimensional ranking. The y-axis depicts the suitability to the OI situation, which is consistent with the previous ranking. The x-axis depicts the suitability to the different OI partners. These are illustrated by different shapes of markers, i.e. each OI partner has 12 markers for each possible OI method. As shown in Figure 7-23, all markers of an OI method are at the same y-position due to the same OI situation suitability, for instance, university cooperation. In contrast, their x-position differs depending on the specific OI partner. Therefore, along with deriving the best fitting OI method for a specific OI partner, the portfolio allows to identify the best fitting combination of OI partner and OI method for the given OI situation. In general, the more to the upper right corner, the higher is the suitability of an OI method and OI partner combination. In addition, trigger and exclusion criteria are highlighted according to the previous bar chart.

In any case, it is important to consider that the purpose of the ranking is to support the selection of suitable OI methods and combinations of OI methods and OI partners. The selection itself has to be made discursively by the OI team. By an intensive discussion, the OI team can evaluate strength and weaknesses of the proposed OI methods concerning the specific company and project characteristics. This is particularly important as there might be specific influencing factors that are unique to the company and therefore are not considered by the methodology. It also allows to consider social factors like the individual capabilities of the internal users of the OI method.

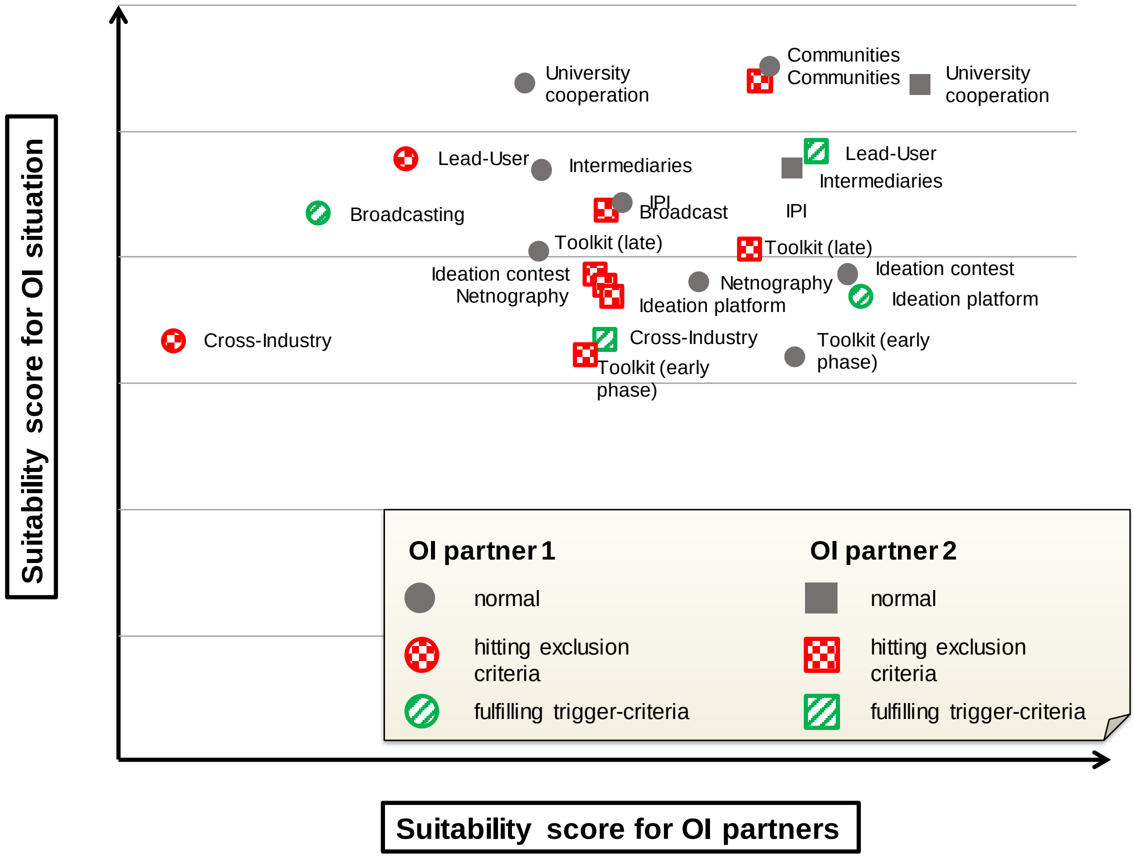


Figure 7-23: Two-dimensional ranking in respect the OI situation and OI partners

Software demonstrator

Due to the high effort of manually handling the DMMs and the matrix calculations, the OI method selection approach was implemented as a software demonstrator[29]. To avoid the use of special software, Microsoft Excel is utilised as basis system due to its wide distribution in companies and academia. It enables an intuitive use without specific foreknowledge, the traceability of the ranking process and results, and a future enhancement by new OI methods. Along with visible spreadsheets as user interface, all DMMs and intermediate vectors can also be assessed via hidden spreadsheets. This ensures transparency of the ranking process and potential individual adaptions by later users.

In the **first step**, the tool user inserts the results of the **OI situation analysis** on the first spreadsheet, which is usually already done in SOI-1. As illustrated in Figure 7-24, the user can choose the particular specifications of each situation criterion from a dropdown list. The default weighting factor is five but can be individually adapted for each criterion on a scale from zero to ten (the higher, the more important). Zero means an exclusion of the specific criterion from the ranking process. Analogously, the favoured OI partners derived from SOI-2 are inserted into the tool on the second spreadsheet. As shown, the tool allows to insert **up to five favoured OI partners**. It is possible to individually activate or deactivate OI partners for the ranking process. For the final presentation of ranking scores, each OI partner has to be labelled by a distinctive name. All inputs are converted to an OI situation input respectively OI partner input vectors on a separate hidden spreadsheet.

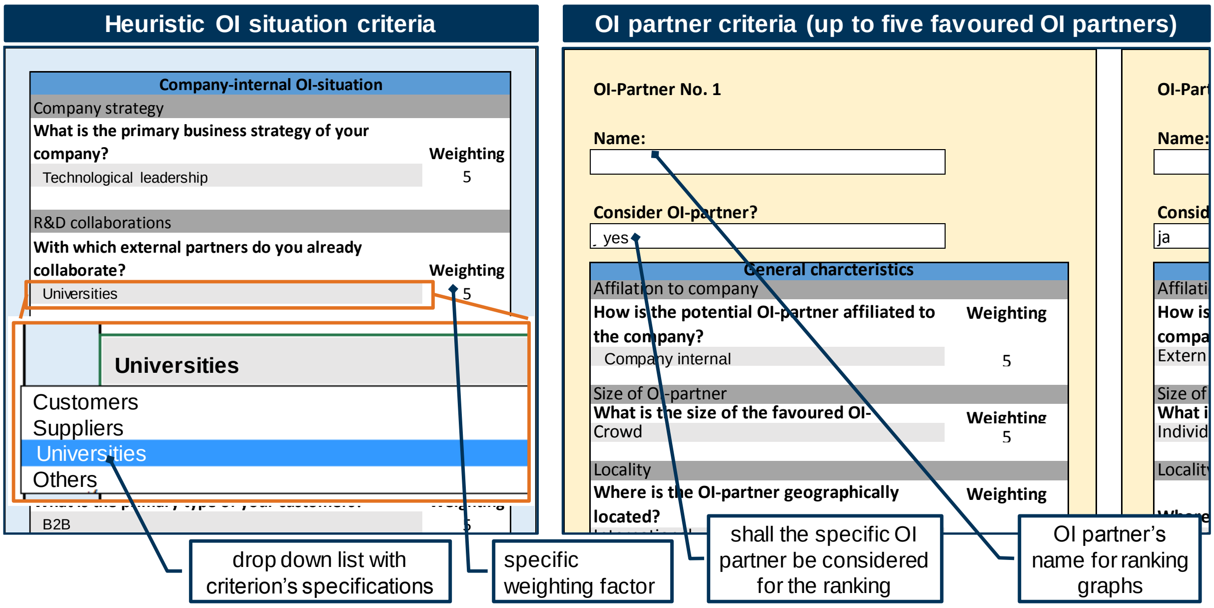


Figure 7-24: User interface for data input: (left) OI situation and (right) up to five OI partners

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[29] In the following the term "tool" is used as synonym to "software demonstrator". Nevertheless, it is an academic tool that focus on proving the applicability of the underlying methodology. It is not comparable with commercial software systems in respect to usability and stability. The tool is originally implemented in German but all screenshots are translated in English to increase comprehensibility.

In the next step, the input vectors are multiplied with the OI situation and the OI partner DMMs. Figure 7-25 shows a section of the OI situation DMM on a hidden spreadsheet. Subsequently, the two resulting intermediate vectors are multiplied with the 12 OI method vectors. The resulting scalar products represent the suitability to the OI situation and each favoured OI partner for each OI method. They are presented as illustrated in Figure 7-22 and Figure 7-23

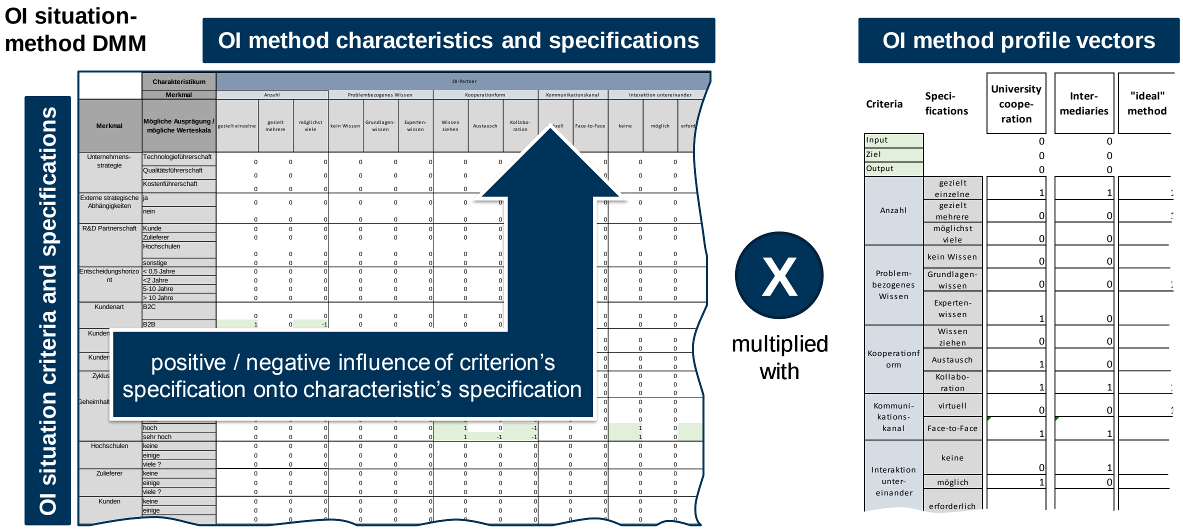

Figure 7-25: Section of the OI situation-method DMM (left) and the OI method profile vectors (right)

In addition to the coloured highlighting in the ranking graphs, another spreadsheet gives a detailed overview of the specifically applying trigger and exclusion criteria of each OI method, as shown in Figure 7-26. The criteria are also differentiated in respect to their source, i.e. the OI situation or the specific OI partner. Stating the critical specification of each criterion of exclusion respectively trigger criterion allows a profound understanding of the specific strength and weaknesses of all OI methods for the particular OI situation and OI partners.

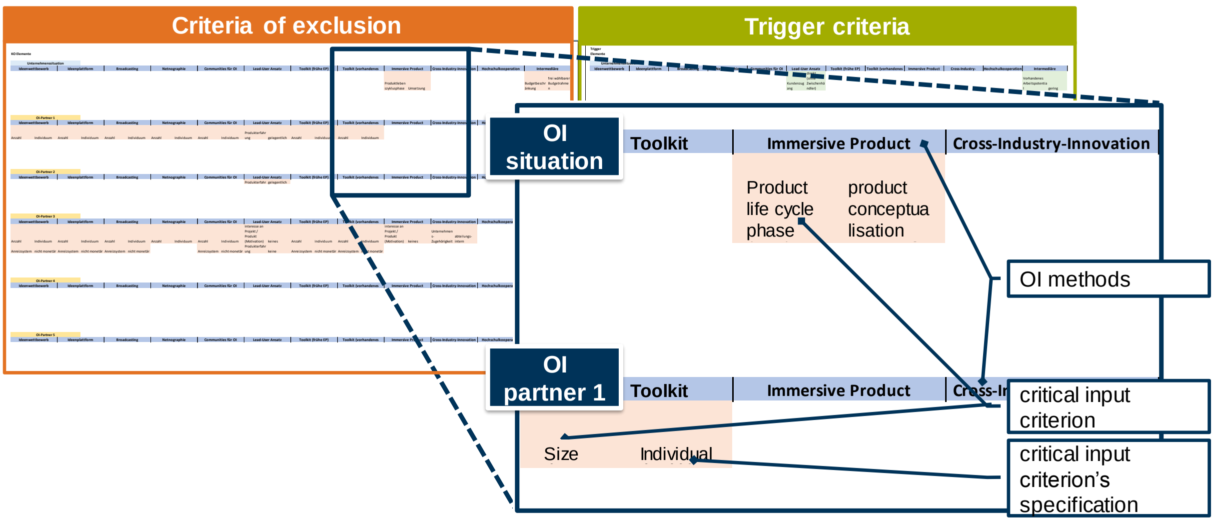

Figure 7-26: Overview of applying trigger and exclusion criteria of each OI method

7.4.3 Deriving the need of adaption

The detailed evaluation of the criteria of exclusion, as shown in Figure 7-26, also supports the identification of the method-specific need of adaptions. Criteria of exclusion indicate aspects of OI methods, which does not meet the requirements of the OI situation or the favoured OI partners. The OI team discursively needs to analyse these aspects whether they really exclude the particular method or they can be resolved by adaptations. For instance, a common criterion of exclusion of ideation contests is a high need of secrecy. This can be resolved by adaptions, such as executing it company-internally, controlling the access of participations and additional refinement of the specific task. The OI method profiles additionally support this team discussion.

7.4.4 Control questions to evaluate the planning progress

The following control questions in support the OI team in reflecting the planning progress in terms of completeness and considering the most relevant outcomes of this phase. This provides guidance and orientation within the planning process. Table 7-14 support the OI team in reflecting the planning progress in terms of completeness and considering the most relevant outcomes of this phase. This provides guidance and orientation within the planning process.

Table 7-14: Control questions to evaluate the OI method selection

Aspect	*Questions*
Evaluation of the OI method selection	• Do OI methods exist, which have a high ranking score in respect to the OI situation and favoured OI partners? Otherwise, the hitherto considered TOP-5 OI partners need to be replaced by backup OI partners, e.g. TOP-10 OI partners. • Does the OI partner-method combination ranking of the portfolio propose another OI partner then originally favoured by the OI team? • Does the required time and resources of the favoured OI method meet the OI project's constraints? • Do criteria of exclusion exist for the favoured OI method? Can they be resolved by adapting the OI method? • Have all results, decisions and necessary adaptions been sufficiently documented?

7.5 SOI-4 - Planning of Open Innovation project management

Although SOI primarily focusses on analysing an OI situation and selecting suitable OI partners and OI methods, this chapter develops initial concepts for planning the OI performance controlling, risk management and incentive strategies. These aspects are relevant to ensure a holistic planning of OI projects. In this respect, SOU sets up a framework, which allows a systematic integration of corresponding methods and tools in the future. Due to their specific complexity and scope, each of these research gaps/fields needs to be addressed in more detail by future research.

7.5.1 Performance and success controlling of the Open Innovation project

Innovation controlling is essential for the success of an innovation process and an OI project (BRANDT 2004, p. 29; GASSMANN AND PEREZ-FREIJE 2011, p. 394), since they do not work autonomously but require continuously observation and controlling (GASSMANN 2013, p. 49f). It is closely linked to other aspects of project management, such as quality, risk and change management (BRANDT 2004, p. 20). The central purpose of an OI controlling is to support the planning and controlling of the OI process, to coordinate and adapt organisational and personnel management. It also offers measures and methods to assess external knowledge, and provides continuously profound and relevant information of the innovation process (ENKEL et al. 2011, p. 1162f; HASKINS 2006, p. 5.4f; HILGERS AND PILLER 2009, p. 6f). It needs to be set up in the beginning of an OI project to allow an efficient utilisation of budget, responsibilities and handling of controlling information (HILGERS et al. 2011, p. 84).

However, innovation controlling and particularly OI controlling face different challenges, such as a suitable balance between freedom of action to foster creativity and control of activities (GASSMANN AND PEREZ-FREIJE 2011, p. 394; HILGERS AND PILLER 2009, p. 10). A major challenge is the time and logical delay between the source or trigger of an innovation and its occurrence. This long time lag and interdependencies of different effects complicate a short-termed evaluation of the success of a finished OI project as well as to link an innovation to a particular project from a long-term perspective (LOCH AND TAPPER 2002, p. 185f; SPITHOVEN et al. 2010, p. 378). In addition, innovation controlling and the suitability of its particular metrics are highly dependent of the OI context and project (GASSMANN AND PEREZ-FREIJE 2011, p. 394f) and the applied OI methods (BLOHM et al. 2011, p. 102). This means, metrics (also called ***key performance indicators (KPIs)***) need to be defined situation-specifically. The OI team has to consider their purpose, way of measurement and resulting consequences in terms of controlling measures (BENAIM et al. 2015, p. 216f; BRANDT 2004, p. 72; ENKEL et al. 2011, p. 1163; GASSMANN AND SUTTER 2008, p. 18). In general, it is necessary to holistically evaluate the success of OI from a multi-level perspective (GASSMANN AND PEREZ-FREIJE 2011, p. 394; HILGERS AND PILLER 2009, p. 9; WEST et al. 2014, p. 809).

Figure 7-27 illustrates the **four layer model of OI performance controlling**, which was developed in this dissertation as a framework to systematically structure OI KPIs[30]. Based on the concept of the *Munich Concretisation Model* (PONN AND LINDEMANN 2011, p. 27), it uses the concept of different evaluation levels from innovation controlling (BRANDT 2004, p. 59; HILGERS AND PILLER 2009, p. 7f), the *ZOPH model*[31] (KLEEDÖRFER 1998, p. 60) and the *Three-Layer Model* (GIAPOULIS 1998, p. 103). The resulting **layers** are (1) **company level** for evaluating global and strategic long-term effects, (2) **new product development level** for strategic medium-term effects onto the innovativeness of a company, (3) **OI project level** for operative medium- and short-term effect of the focal OI project, and (4) **OI method level** for the operative and short-term evaluation of specific innovation activities and methods. The layer

[30] It is based on an initial concept of PE: GINARD (2015). For more details of all student theses see appendix 13.1.

[31] The German acronym of *„Ziel-, Objekt-, Prozess- und Handlungssystem“* (system of objectives, of objects, of processes and of activities).

model was enhanced by **OI process phases** as second dimension. They comprise OI project phases (cf. Figure 1-1) and subsequent innovation process phases, based on PLC aspects from system engineering (cf. HASKINS 2006, p. 3.3f). This second dimension allows the consideration of interrelationships and dependencies between layers and project phases. For instance, the *number of new OI partners* might be a KPI in the planning phase on the OI project level, while the *PR impact of this collaboration* can be a KPI on the company level. The third dimension differentiates KPIs into (1) **input**, e.g. *required workforce and budget, time*, (2) **output**, e.g. *project quality, number of patents, adherence to schedule, failure and change costs*, and (3) **process metrics**, e.g. *milestones, deadlines and number of parallel projects* (GASSMANN AND PEREZ-FREIJE 2011, p. 394; HILGERS et al. 2011, p. 85).

This framework supports OI teams in situation-specifically defining appropriate KPIs for a particular OI project. In this respect, monetary and non-monetary as well as qualitative and quantitative KPIs need to be combined for a holistic evaluation (ENKEL et al. 2011, p. 1163; HILGERS AND PILLER 2009, p. 8; LOCH AND TAPPER 2002, p. 196). Existing approaches can be used as basis and source of potential KPIs, such as balanced scorecards (KAPLAN AND NORTON 1992; LOCH AND TAPPER 2002), Open Innovation Scorecards (HILGERS AND PILLER 2009, p. 8), Idea Community Scorecards (BLOHM et al. 2011) and the resources-based controlling approach for OI (HILGERS et al. 2011, p. 86).

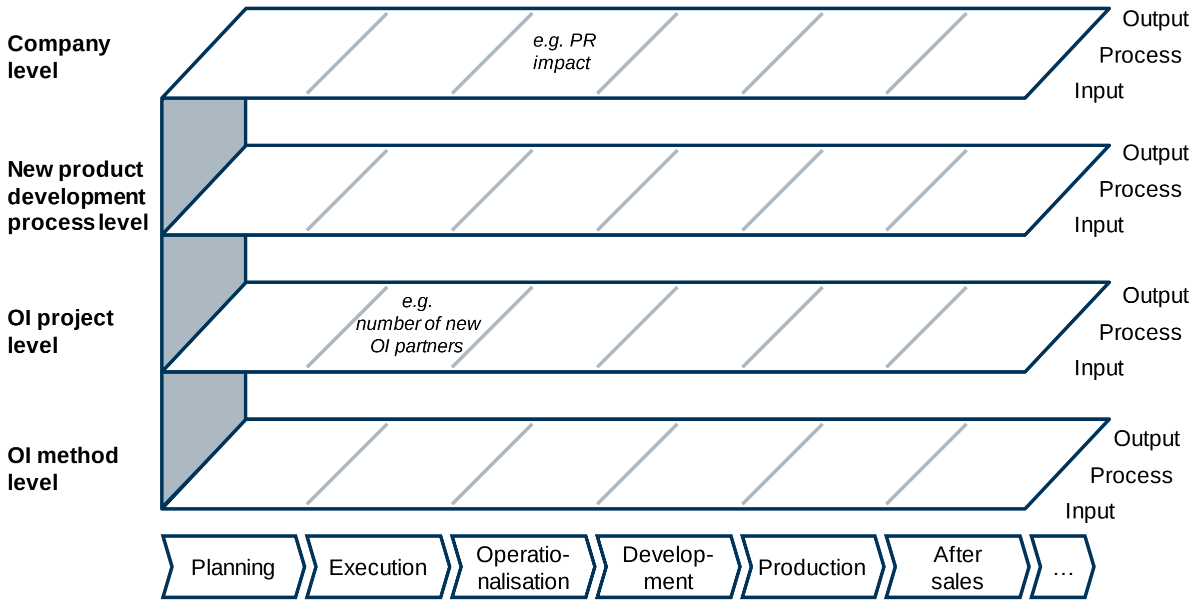

Figure 7-27: Four layer model of OI performance controlling

7.5.2 Identifying and managing risks of the Open Innovation project

To ensure a successful collaboration with the selected OI partners, it is essential to identify potential risks, which can result from a specific OI situation, the OI partners and OI methods. Different risk management approaches from traditional (closed) project management exist, which differ in details but show a common basis, such as ILEVBARE et al. (2014), OEHMEN et al. (2010; 2014), PMI (2013, p. 309f), and VERBANO AND VENTURINI (2011). An established standard is ISO 31000, which is applied within SOI, as illustrated in Figure 7-28 (ISO 31000).

Based on the results of SOI-1, the first step **establishes the context** of the risk analysis, such as its scope and role for the OI project. In the subsequent **risk identification**, potential risks, causes and effects are detected. These are assessed in detail in the **risk analysis**, which is the basis of the following **risk evaluation** concerning their specific relevance. Appropriate **risk treatments** are developed for each derived relevant risk, evaluated in terms of costs and benefits, and selected. It is essential to continuously **monitor and review** each of its steps and activities to ensure the success of risk management. Another central element is the **communication (with) and consultation** of relevant internal and external stakeholders, i.e. an appropriate strategic involvement (cf. SOI-2). On the one hand, these stakeholders are relevant to treat OI risks. On the other hand, they themselves represent a central source of potential risks, for instance, due to holding back knowledge, opportunistic behaviour, inefficient management decisions and conflicting incentives (HYLL AND PIPPEL 2016, p. 466).

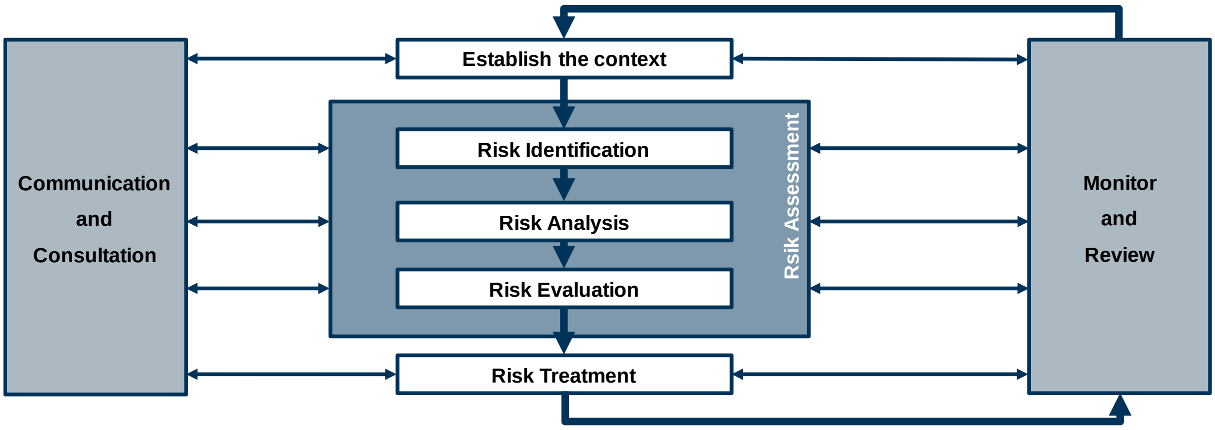

Figure 7-28: Risk management process of ISO 31000 (based on: OEHMEN et al. 2010, p. 1035)

Hitherto, SOI supports OI teams in getting sensitised for and in identifying potential OI risks. It provides an overview of potential risks along with an indication of their particular relevance based on a **structural ABC-analysis** of risks interdependencies, cf. appendix 13.7.4 and GUERTLER et al. (2015d). The OI team can use this list as basis of a discursive identification and selection of particularly relevant and critical OI risks. In addition, other authors offer initial indication of links between chances and risks depending on, for instance, specific **OI partners**, such as universities, competitors, suppliers, customers and consultants (PERKMANN et al. 2011), on **OI process phases** (ENKEL et al. 2005a, p. 205) and **crowdsourcing-specific risks** (GASSMANN 2013, p. 37). They are shown in the appendix 14.7.

Based on this, the OI team can develop appropriate treatments. For instance, ALBERS et al. (2014b, p. 488f) identified internal innovation barriers and propose according treatments, for instance, preventing the **NIH syndrome** (cf. chapter 2.3.4) by showing the benefit of the project and building trustful relationships, avoiding a **missing technological fit of new technology** by analysing internal needs and requirements before the project start, avoiding a **missing economic and technical advantage of new technology** by deriving suitable assessment criteria to show benefits and limitations of external knowledge, and openly discussing potential shortcomings. To increase the acceptance of an OI project by internal stakeholders, GIANNOPOULOU et al. (2011, p. 516) stress the relevance of **success stories**, which are derived from finished OI projects. In addition, MEYER AND MEYER (2011, p. 92f) present treatments, which specifically focus on **IP hygiene risks**, such as OI partners confirming that they hold the rights of an idea and a modulating degree of confidentiality.

7.5.3 Incentive strategies for motivating OI partners

It is crucial for the cusses of an OI project to choose the right incentives for motivating OI partners (Bogers and West 2012, p. 69). OI partners are only going to collaborate when they gain some kind of benefit from it (Bergmann et al. 2009, p. 146). In addition to incentives for external OI partners, it is also essential to sufficiently motivate and involve internal stakeholders to use their expertise and prevent internal barriers (Giannopoulou et al. 2011, p. 508f; Solesvik and Gulbrandsen 2013, p. 15). Along with its relevance, suitable incentive strategies are complex and still subject of ongoing research, although there are already partial approaches. These usually focus on specific types and methods of OI, such as company-internal ideation communities (Albers et al. 2013), ideation contests (Wenger 2014), crowdsourcing in general (Gassmann 2013) and cross-industry workshops (Enkel et al. 2009a).

In general, traditional motivation psychology differentiates **individuals** with specific motives, who are in a specific environment and **situation**, which can also include incentives. Both lead to a current **motivation** of individuals, which triggers a specific **behaviour** (Kehr 2009, p. 18; cf. Zerfaß 2009, p. 30). Motives are based on three fundamental motives: (1) **need for affiliation**, (2) **need for achievement** and (3) **need for power** (Albers et al. 2013, p. 526; Holle et al. 2014, p. 1; McClelland et al. 1989). They can be structured in **intrinsic and extrinsic motives** and **perceived abilities** (Giannopoulou et al. 2011, p. 516), which can be addressed by pecuniary and non-pecuniary incentives (Bogers and West 2012, p. 69). An overview of different ***intrinsic and extrinsic motivational factors*** is provided by Kirschner (2012, p. 58f) and Schattke and Kehr (2009, p. 124), see appendix 13.8. Along with them, Holle et al. (2014, p. 4), in line with Albers et al. (2013, p. 531), present the following three perceived abilities, or so called ***hygiene factors*** that enable the performance of incentives: **trust** of OI partners in the company, **openness** of participation for interested OI partners, and **accessibility**, i.e. OI partners can easily participate. In this respect, a major challenge is that each OI partner is an individual or group of individuals, who have unique needs, motives and reactions to incentives (Albers et al. 2013, p. 527). To define appropriate incentives, the OI team needs to evaluate the specific motives of their focussed OI partners, their situation (in general and in the context of the planned OI method) and their resulting motivation.

In accordance to Gassmann (2013, p. 51f, 60f), Albers et al. (2013, p. 528f) identified the following explicit and implicit motives and according stimulation methods. In respect to explicit motives, the **relevance of an innovation community (OI method) and the specific innovation tasks** need to be stressed. To address implicit motives, the OI partners’ **need of affiliation** to other stakeholders should be stimulated by personal message and chat functions, the **need of achievement** by user feedback and rating functions, and the **need of power** by publicly associating ideas to OI partners, along with offering specific functions and awards depending on the individual performance. Particular elements of incentives are the ownership of developed IP and the according exploitation rights (Bogers and West 2012, p. 70; Gassmann 2013, p. 52). For instance, giving back the exploitations rights to the OI partners after a specific time or giving them a share of the profit can increase their motivation. Other authors also focus an methods to increase the attractiveness of a company to potential OI partners, such as McFathing (2011, p. 179f) and Meyer and Meyer (2011, p. 96).

In addition to incentives focussing on crowdsourcing, Enkel et al. (2009a, p. 151f) empirically analysed motives of accepting and rejecting invitations to cross-industry workshops. They found the following **supporting motives**: interest in the host company, interest in the wanted solution, interest in the topic of the workshop, learning new methods, extending the personal network, being a former employee of the company and the chance of sharing knowledge. **Motives of rejection** were a lack of time, a lack of resources, a high distance between the own business area and the topic, being competitors, a perceived lack of expertise concerning the topic, a perceived negative cost-benefit ratio, and a lack of monetary incentives. Another important **participation barrier**, which evinced from an evaluation case study (chapter 8.3), is some OI partners being mutual **competitors**. In this case, the OI team needs to change the set of favoured OI partners. Otherwise, it risks a rejection of the participation invitation or a negative atmosphere during the OI project as everyone holds back relevant information.

7.5.4 Control questions to evaluate the planning progress

The following control questions in Table 7-15 support the OI team in reflecting the planning progress in terms of completeness and considering the most relevant outcomes of this phase. This provides guidance and orientation within the planning process.

Table 7-15: Control questions to evaluate the planning of the project management

Aspect	***Questions***
Evaluation of the planning of the project management	• Does the reputation of the selected OI partners match the company's PR? • Do success stories of (open) collaboration projects exist, which can be used to motivate internal stakeholders? • Is the handling of IP ownerships and exploitation rights of gained OI input defined? • Does the incentive strategy address extrinsic as well as intrinsic motives? • How can a trustful relationship to OI partners be established? • Do the OI method, its level of openness and corresponding methods of knowledge protection fit to the project-specific need of secrecy? • Do strategies exist how to react to insufficient participation of OI partners, insufficient outcomes of the OI project, negative group dynamics of crowds, competitors trying to sabotage the OI project, or OI partners trying to cheat and manipulate results? • Does the performance assessment also consider "soft" effects, such as learning effects or improved business networks?

7.6 SOI-5 - Detailed planning of Open Innovation projects

While the previous phases define **what** should be done in the OI project, the purpose of this phase is to plan in detail **how** the planning elements shall be realised. Therefore, this phase is highly dependent on the specific OI situation and OI project. In general, SOI-5 comprises elements of traditional project management (Kerzner 2009; PMI 2013) and of dynamic approaches (Moser and Wood 2015), such as defining specific project plans, setup of Gantt charts, simulating possible project progressions and planning resources. Due to the complexity and effort of these approaches, the OI team needs to decide which elements are necessary: while the elaborate development of a simulation model can be reasonable for a superordinate R&D project, a Gantt chart might be sufficient for an OI project. For a detailed consideration refer to the referenced publication. In the following, the most relevant aspects for OI projects are discussed, based on the experience of the research project *KME – Open Innovation*.

Involvement of OI partners

Based on the decision to choose specific OI partners, the OI team needs to plan their **acquisition**. The central element is the identification of specific contact persons. Often, they are already known from the OI partner search (cf. SOI-2) or can be identified, for instance online using social media platforms like LinkedIn. If no specific contact is known, the reception of the particular organisation should be called and asked for a suitable contact. Closely linked, an appropriate medium needs to be defined. For small OI partner groups with specific contacts, usually an initial phone call is suitable. It allows to explain the topic and the rough OI project setup, followed by an email with further details. For crowds, the medium depends on their characteristics and can range from invitations on websites, social media platforms and emails to print media, TV and radio. In addition, the OI team needs to analyse a suitable time when to contact an OI partner. For instance, ENKEL et al. (2009a, p. 156f) provide specific recommendation for cross-industry workshops, such as stressing the particular benefits for OI partners, and their capabilities for solving the task of the workshop.

Along with the acquisition, the **incentive strategies** need to be detailed, including aspects, such as the specific name of awards, the number and frequency of rewards, frequency, the type and amount of profit-sharing, the duration of the company's exclusive right of exploitation, and the formulation of non-disclosure agreements (NDAs) and terms of participation.

Planning of OI methods

The detailed planning of OI methods comprises the dimensions of time, location and content. Concerning the **time** dimension, the OI team needs to define the specific start and duration of an OI method. In this respect, the consideration of specific cultural or regional holidays is crucial to ensure a high level of participation, such as religious or school holidays. In addition, the OI team should identify situations where the motivation of OI partners is high, for instance, when waiting for something.

This is closely linked to the selection of a suitable **location** of involvement based on the consideration where potential OI partners are likely to be motivated to participate. For instance, for train journey related topics, an involvement of passengers is beneficial, when they are waiting at a train station or travelling in a train. This also avoids breaks of location and time, which can reduce the quantity and quality of OI input. Along with this, it is important to reduce entry barriers as far as possible without risking knowledge drain. MEIGE AND GOLDEN (2011, p. 190) state the registration on a web platform as its central participation barrier. In the case of a web-based OI method, the OI team needs to decide either to implement an own platform or use an existing one. This means, existing platform providers need to be identified and analysed concerning their suitability and fit to the PR image.

From a **content** perspective, the OI team needs to define the task description depending on the specific OI partners and OI methods. GASSMANN (2013, p. 181f) stresses the need of an

OI partner-specific task description that is neither too abstract nor too specific. At this, granular and defined tasks are particularly useful for web-based OI methods (HILGERS et al. 2011, p. 89). Usually, it is possible to provide supportive material to increase the problem and task understanding of OI partners, such as background information, videos and (virtual) prototypes.

In general, it is necessary to **provide OI partners with central information** about their involvement and OI method. This means, for instance, the communication of the host of a workshop, its location, other participants, agenda, goal, success criteria and following steps (JÖRGENSEN et al. 2011, p. 157f).

Detailed planning of project management

In addition to aspects, which are directly linked to OI partners and OI methods, other project phases-spanning aspects need to be considered, such as the provision of sufficient IT server capacity, and strategies of reacting to insufficient participation of OI partners in the **execution phase** (cf. GASSMANN 2013, p. 185).

Concerning the **operationalisation phase**, the OI team needs to plan how to process the gained OI knowledge (cf. KAIN 2014), particularly if the OI input is less or more than expected (GASSMANN 2013, p. 187). In the case of involving OI partners into the OI knowledge evaluation process, strategies should be defined how to act if the external assessment contradicts the company internal one (GASSMANN 2013; LAURITZEN 2015).

In addition, the OI team also has to consider the **final exploitation** phase in their planning. Along with the evaluation and processing the OI input, resources and responsible actors need to be assigned for feeding the processed OI input the internal innovation process. Other exemplary aspects are the consideration of internal barriers like Not-Invented-Here syndrome or the handling of IP rights (GASSMANN 2013, p. 189; GIANNOPOULOU et al. 2011, p. 517).

Table 7-16 gives an overview of references that provide further details of specific OI methods.

Table 7-16: Exemplary references for detailed planning of specific OI methods

OI methods	**Exemplary references**
Ideation contest	(BLAESER-BENFER et al. 2007; DIENER AND PILLER 2010, p. 88f; FINGERLE 2011; GASSMANN 2013; PIRKER et al. 2010; WALCHER 2007; WENGER 2013; 2014)
Ideation platform	(GASSMANN 2013)
(Problem) Broadcasting	(DIENER AND PILLER 2010, p. 95f; GASSMANN 2013; PIRKER et al. 2010; ZYNGA 2015)
Community for OI	(BLOHM 2013b; EBNER 2008; LEIMEISTER AND KRCMAR 2006; MAUL 2015; WENDELKEN 2015)
Netnography	(BELZ AND BAUMBACH 2010)
Lead-User approach	(DIENER AND PILLER 2010, p. 96f; HIPPEL 2005)
IPI	(KIRSCHNER et al. 2011; KIRSCHNER 2012)
Toolkit	(DIENER AND PILLER 2010, p. 93f)
Cross-Industry Innovation	(ECHTERHOFF 2014; ENKEL et al. 2009a; ENKEL AND HORVÁTH 2010; FRANKE et al. 2014; GASSMANN et al. 2011)
University cooperation	(PHILBIN 2008)
OI intermediary	(DIENER AND PILLER 2009; 2010, p. 102f; GASSMANN et al. 2011; GASSMANN 2013; ZYNGA 2015)

7.7 Recapitulation and continuous improvement process

As indicated in previous chapters, the planning of OI projects is highly dependent on the specific OI situation and skills of the OI team, which cannot completely be covered by a methodology. In addition, the planning is based on the experience of the OI team. Therefore, it is essential to retrospectively analyse each finished OI project concerning positive aspects, challenges and potential improvements to allow a ***continual improvement process*** and learning for future OI projects (cf. ALBERS et al. 2005, p. 6; REINHART et al. 1996, p. 32; SREENIVASAN AND NARAYANA 2008, p. 17f). This reflection should be conducted within the OI team but also involve other internal stakeholders to allow a different perspective. The results have to be sufficiently documented and be assessable to future OI teams.

The questions in Table 7-17 support in reflecting and evaluating the OI situation analysis, the fit of OI partners and OI situation, the fit of OI methods and OI situation, the fit of OI partners and OI methods, and the performance of incentives, risk management and project controlling. They do not claim completeness but comprise the most relevant aspects (based on the experience from the research project *KME – Open Innovation*) and trigger further reflections.

Table 7-17: Reflexive questions to support a continuous learning process

Aspect	***Questions***
OI team	• Was the collaboration and teamwork within the OI team successful? • Would additional or other team members have been more beneficial for the planning and execution of the OI project? • What the personnel size of the OI team sufficient? When and why was it insufficient?
OI situation and problem analysis	• Were all situation criteria assessed correctly? What were the reasons if not? • Did additional situation criteria evince to be relevant during the OI project and should also be considered in the future? • Was the level of abstraction of the problem analysis appropriate?
Fit of OI partners and OI situation	• Were the selected operative OI partners suitable to solve the given problem within the specific OI situation? Were there reasons for not involving particular OI partners? • Were the selected strategic OI partners supportive for the success of the OI project? • Were there other actors that should have also been involved from a retro-perspective point of view? For which reasons? Why were they not involved?
Fit of OI methods and OI situation	• Were the selected OI methods suitable to solve the given problem within the specific OI situation? What are reasons for another OI method? • Were the assigned resources, time and workforce sufficient for the OI project?
Fit of OI partners and OI methods	• Were the selected OI methods suitable to operatively involve the OI partners? • What would be reasons for another OI partner-method combination?
Performance of incentives	• Were motives and the individual situation of OI partners evaluated correctly? • Were the selected incentives successful? • What are reasons for alternative incentives?
Performance of risk management	• Were all relevant risks and barriers identified in advance? Which ones were neglected due to what reasons? • Were the relevancies of risks assessed correctly? What were the reasons if not? • Were all critical risks addressed by suitable treatments? • Were all successfully applied risk treatments documented (e.g. in a crisis handbook)?

8. Industrial evaluation of Situational Open Innovation

This chapter presents the case study-based evaluation of the developed Situational Open Innovation methodology. To analyse the benefits and limitations of SOI from different perspectives, each of the three case studies has its specific focus. This is the basis of a detailed discussion concerning the methodology's fulfilment of the previously defined requirements.

8.1 Overview and categorisation of evaluation case studies

The evaluation of the SOI methodology is based on case studies (cf. YIN 2014). The resulting intensive cooperation with each industry partner allows a qualitative in-depth analysis of benefits and limitations as well as the identification of enabling success factors and barriers of the methodology's application in industry. In addition, regular discussions with the industry partners and the results of an evaluation questionnaire provide direct feedback from the perspective of the industry partners (appendix 13.9). As each case study has a different goal and boundary conditions, it is possible to evaluate the context-spanning applicability of the methodology and derive indications of its generalisability. While the **first case study** focusses on a broad search for new OI partners to develop a new alloy material in a secrecy-sensitive market environment, the **second case study** aims at the development of a solution for a technical problem. The **third case study** addresses the development of a new product service system (PSS) in the context of manufacturing plants. Intermediate results of these case studies were already presented in the following publications to foster discussions with international researchers and gain valuable feedback: GUERTLER et al. (2015b), GUERTLER et al. (2015e), GUERTLER et al. (2015c) and (GUERTLER AND LINDEMANN 2016a).

Table 8-1 gives an overview of the case studies (CS). Along with these three "large" ones (CS 1-3), particular elements of SOI were evaluated in smaller case studies, which are presented in separate publications. As SOI focusses on the planning phase of OI projects, the execution phase of the OI projects is not in the primary focus of the following evaluation. Case study 2 exemplarily shows how the developed project plan is used during the execution phase.

Table 8-1: Overview of evaluation case studies

#	Case study (CS)	Focus of evaluation
1	Automotive supplier	Focus on a broad search for new OI partners in a secrecy-sensitive market environment (focus on SOI-1 and SOI-2)
2	Manufacturer of building technology products	Focus on developing solution ideas and concepts for a technical problem (focus on entire SOI)
3	Manufacturer of production plants	Focus on developing the basis and initial ideas for a new product service system (focus on entire SOI)
-	GUERTLER et al. (2016b)	Detailed evaluation of the OI situation analysis in cooperation with the previous three companies (focus on SOI-1)
-	GUERTLER (2014)	Detailed analysis of the strategic operative portfolio in cooperation with an automotive manufacturer (focus on SOI-2)

In the following, the particular industry partner of each evaluation case study is addressed by "***the company***". The characterisations are based on the specific situation analyses (cf. SOI-1).

8.2 Searching for new R&D partners in a confidentiality sensitive industry

8.2.1 Characterisation of company and Open Innovation goal

The first evaluation case study was in cooperation with a family-owned SME, which – among others – manufactures mechanicals parts for the automotive industry. These parts are highly durable with a minimal use of material, and are designed and produced customer-specifically. In this respect, it is essential to develop new materials and make them ready for industrial production to fulfil the continuously increasing customer requirements and stay successful within a highly competitive market. The underlying R&D process is not trivial since production processes, which work in a laboratory scale, are usually not directly scalable to industrial scales.

The goal of the particular OI project was the identification of R&D partners for developing such a new material for a high-strength component from the scratch. The company had already gained some basic knowledge of the focused alloy but only on a laboratory scale. Along with the design of the component, in particular the design of the industrial production process evinced to be difficult. Due to strict requirements of geometry and durability, the type and sequence of process steps are important. Insufficient settings can negatively influence the geometry or cause high tooling costs. As the company could not solve this challenge alone, it was looking for external R&D partners with product as well as process expertise. The focus was on new and hitherto unknown OI partners since the existing external partners had no specific knowledge for this type of alloy. Due to the high specificity of the topic and no direct contact between the product/component and the end users, the general search focus was on OI partners from industry and academia. Due to the highly competitive market situation, the major constraint for the OI project was a high need of secrecy. Even the information about the focused alloy or the OI project itself was considered a strategic threat if getting known to externals. In addition, there was a strong economic and strategic dependency of the company from their customers, in particular from original equipment manufacturers (OEMs).

The company already had experience with cooperating with external partners, such as horizontal R&D partners, suppliers, customers and academia. Except principal knowledge about the concept of OI, the company had no experience with OI but was motivated to test it.

8.2.2 Application of SOI methodology

The OI project was initiated by the director of the corporate development, who belongs to the entrepreneur’s family. Along with strategically supporting the OI project, he also operatively participated in planning workshops. The core OI team comprised the manager and an R&D engineer of the specialised department, and an R&D engineer from a central innovation department.

In the context of the OI situation analysis, the OI team analysed the OI goal concerning necessary expertise and capabilities of potential OI partner. These were documented as operative OI partner criteria. A detailed problem analysis was not conducted as the criteria could be derived from the characteristics of the alloy and the underlying production principles.

Selecting Open Innovation partners

Based on the analysis of the OI goal, the OI team defined the following operative OI partner criteria that comprises the **three basic criteria** (B1) *expertise in producing steel alloys*, (B2) *expertise in forming steel alloys*, and (B3) *expertise with high durability alloys*, the **two performance criteria** (P1) *expertise in heat treatment of steel alloys* and (P2) *production capacities*, along with the **two excitement criteria** (E1) *existence of own R&D laboratories* and (E2) *existence of own test centres*. Although, the company was looking for expertise with a specific steel alloy, the OI team broadened the partner criteria by orientating by the underlying properties of the alloy. This allowed the identification of a large pool of potential OI partners. **Strategic partner criteria** were the central (S1) *interest and motivation in cooperating* as well as the (S2) *willingness to work in automotive industry* and the OI partner's (S3) *market strength*.

Subsequently within a workshop, the OI team **analysed the network of existing stakeholders** concerning different stakeholder classes, specific stakeholders and their dependencies by using a flipchart-based stakeholder map. Figure 8-1 shows the resulting digitalised stakeholder map. Central element is its innovation process that provides guidance in identifying relevant stakeholders along with the provision of common stakeholder classes from literature. The stakeholder analysis ensured a homogenous knowledge level within the department-spanning OI team. It also helped to derive critical stakeholders and critical dependencies from these stakeholders to others, which needed to be considered for the search and selection of new OI partners. Critical stakeholders were highlighted in a darker colour to ensure a continuous awareness of them. In this respect, the paper-based stakeholder map supported team discussions by visualising the stakeholder network.

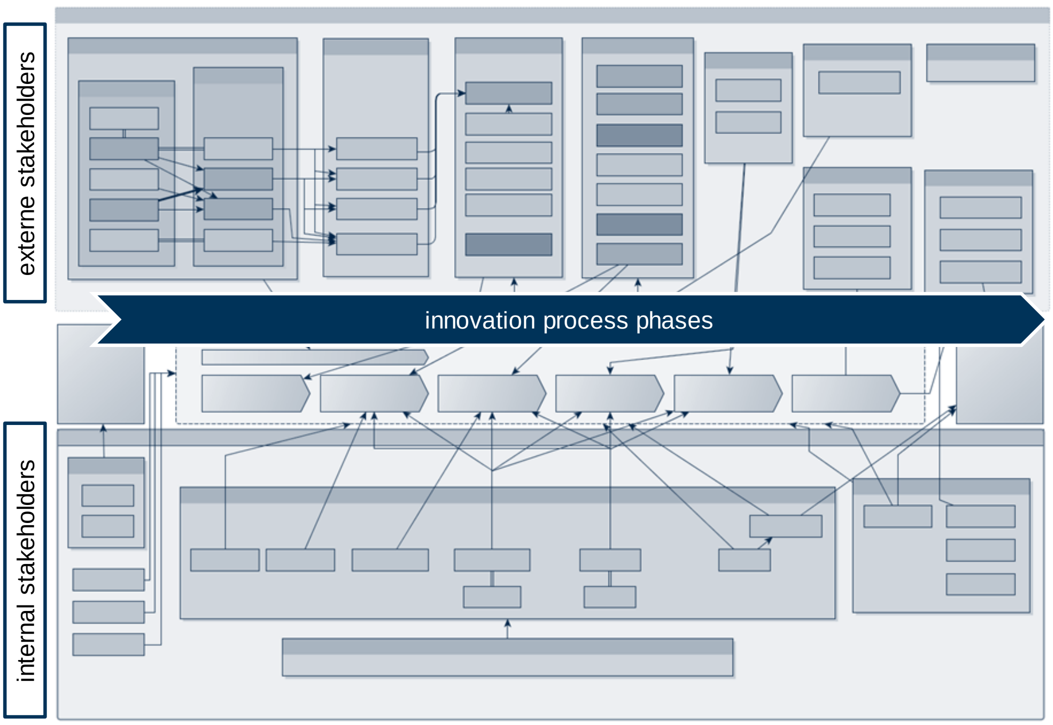

Figure 8-1:Stakeholder map of the automotive supplier

In the **second step**, the basis for the subsequent search for new OI partners was set. Although, the search focus was on new OI partners, an initial assessment of existing stakeholders was conducted to structure these known "*knowledge carriers*". This allowed a later purposeful addition of known partners that could complement specific capabilities of the primary new OI partners. Figure 8-2 shows the resulting **search field matrix** with the innovation process phases on the x-axis and three PLC phases on the y-axis. For the subsequent search, blank "*white fields*" were particularly interesting in terms of new OI partners. Their discussion within the OI team revealed that the fields linked to the process phases of *sales* and *after sales* were blank due to organisational and technical reasons. In addition, a specific search field of general search paths was identified as enabler of the other search fields. The derived search fields are indicated in the figure.

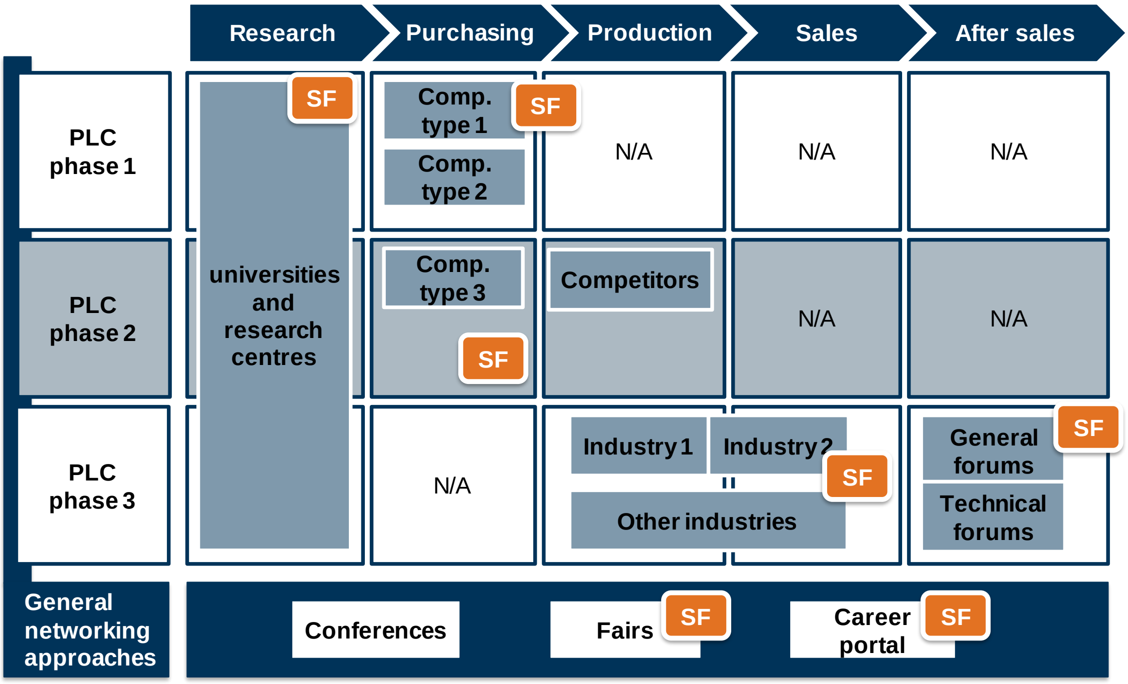

Figure 8-2: Search field matrix for identifying new R&D partners (based on: GUERTLER et al. 2015b, p. 27)

Within these search fields, in the **third step**, the OI team searched for new potential OI partners. Due to the high need of secrecy the **active search path** was chosen since it allowed a better control of the search process and the revealed internal information. Along with media-based searching in public databases (e.g. supplier portals) and search engines, a combination of searching and screening was the visit of a specialised trade fair. To allow an incognito search, the OI team delegated the search to the academic team around the author. The reasons for this search method and adaptions were the lack of preconditions in terms of infrastructure and existing communities, as well as the small effort for learning the search method and a high degree of control by the OI team. In addition, it offered the possibility to gain an overview of the general topic and potential aspects, which were not in the primary search scope. The resulting effort for preparations was medium. It mainly included the definition of search criteria and a suitable "story" for the incognito search at the trade fair as well as the setup of a questionnaire for interviewing potential OI partners. In this case, the search criteria were directly derived from the operative OI partner criteria. Nevertheless, the relevance of one criterion addressing the specifically wanted forming technology was downgraded, in order to allow the identification of potential alternative manufacturing technologies.

In addition, a pyramiding search was conducted. It comprised an initial offline part involving experts from a specialised institute of a university and a subsequent online part. This allowed the use of their expertise and experience from previous collaborative research projects for identifying and initially assessing potential OI partners. The effort for learning this search method was medium. The main challenge was the formulation of the search goal. In comparison to the trade fair, the communication was more open due to a personal and trustful relationship to the institute. Nevertheless, it was not possible to tell them “the full story” and therefore the constraints of the conversation were high. The resulting list of potential OI partners was shorter but of a higher perceived quality than the results from the trade fair. Subsequently, more information of the potential OI partners was gained in the internet and used for an online pyramiding. It analysed their cooperation with academia and industry, which were mentioned on the websites of the potential OI partners. Along with this, also search engines were used including the names of the potential OI partners, and "cooperation"/"Kooperation" or "project"/"Projekt" as search terms. In this respect, the main challenge was the limited access to reliable data

The latter was also the major challenge for the assessment of the potential OI partners in the **fourth step**. In this respect, the categorisation of OI partner criteria proved to be beneficial. The basic criteria were defined in such a way that they could mainly be assessed with publicly available information. In addition to the three operative basic criteria, a strategic basic criterion was considered (*interest and motivation in cooperating*). The direct assessment of all identified potential OI partners after each search method, allowed purposeful search interactions, which used different search methods for evaluation reasons. In the end, circa 180 actors were identified. Of them, circa 45 fulfilled all basic criteria, 55 did not fulfil all basic criteria and the rest suffered from a lack of assessment-relevant information.

In the **fifth step**, all identified potential OI partners were clustered to provide a comprehensible overview to the OI team. The applied table comprised the type of the OI partners (*industry, academia*) on the y-axis and their geographical location (*Germany, Europe, international*) on the x-axis, as shown in Figure 8-3. In addition, a traffic light labelling system was applied to indicate the assessment results of each partner and criterion. While green highlighted fulfilled and red unfulfilled criteria, yellow indicated a specific lack of information. In particular, the evaluation of an OI partner’s *interest and motivation in a cooperation* evinced to be difficult due to the lack of experience with these hitherto mainly unknown actors.

Based on this, the OI team discursively selected their (in this case) **TOP-5 favoured operative OI partners**: three companies from Germany, one from Europe and one international. Along with the already department-spanning members of the OI team, **strategic OI partners** were involved from the process development department as interface between advance development and production, from the purchasing department. While these were involved in a “*consulting*” way (cf. chapter 7.3.6), the top management was involved in a “*informing*” and “*empowering*” way due to project controlling and permission reasons. As particular stakeholder of this initial OI pilot project, the corporate development department was also involved by “*informing*”.

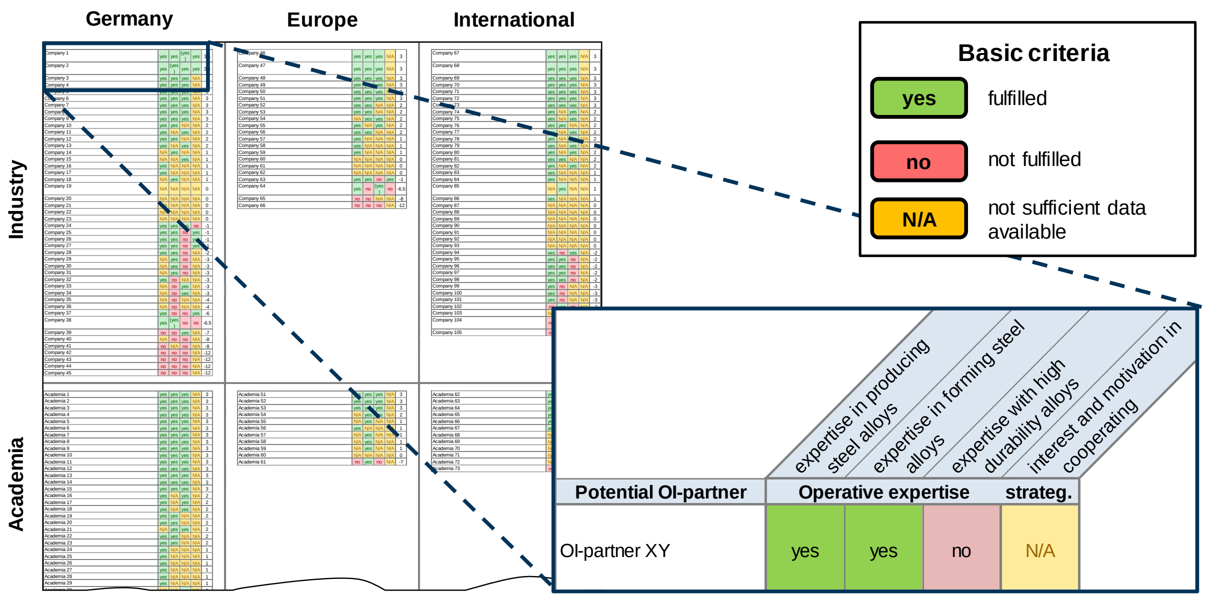

Figure 8-3: Assessed and clustered potential OI partners (based on: GUERTLER et al. 2015b, p. 28)

Selecting and adapting Open Innovation methods

The focus of the OI projects was the identification of potential R&D partners and acquisition of one or two of them in the context of a highly competitive market and a resulting high need of secrecy. Therefore, all OI methods requiring the publication of information were discursively filtered by using the OI method profiles. In the end, dyadic workshops with each OI partner were chosen due to secrecy reasons.

Planning Open Innovation project in detail: focussing on partner acquisition

Due to the high need of secrecy, the OI team considered a direct approaching of the favoured potential OI partners as a strategic risk. Therefore, the academic team around the author acted as neutral facilitator (cf. VARVASOVSZKY AND BRUGHA 2000, p. 341), who established the first contact and attuned the expectations and requirements of each side. The first contact with the favoured TOP-5 partners was realised via email, which was formulated by the OI team of the company to ensure the completeness and correctness of all necessary technical details. Nevertheless, only one OI partner (identified at the trade fair) replied to this email and signalled its interest in a collaboration. Subsequently, further details, expectations and requirements were discussed in a telephone call with the academic team. For instance, the OI partner was interested in a collaboration but only when the purchase quantity was sufficient and the company already financially contributed in the development phase of the new material, i.e. share of R&D risks. All highly specific queries of the OI partner were collected and passed on to the company. The answers were then forwarded to the OI partner. This ensured a neutral and anonymised communication. After ensuring the consensus of the basic expectations and requirements, the OI team directly contacted the OI partner to plan the further steps of the potential collaboration. A subsequent first workshop meeting between OI team and OI partner was successful. Therefore, the defined goal of the OI project was successfully reached from the perspective of the company.

8.2.3 Discussion of case study and results

The goal of the OI project was the **identification of new, hitherto unknown R&D partners** to develop a new alloy along with the underlying production process. Due to its technological complexity and time exposure, the actual involvement of the identified OI partner and the development of a solution were not part of the OI project. The following discussion is based on observations of the closely involved academic team around the author as well as a feedback questionnaire of the company (appendix 13.9).

Although the subsequent involvement of OI partners is likely to be realised by a traditional dyadic R&D cooperation, the search for the R&D partners used specific search approaches from OI and user innovation. The developed OI partner search methodology of SOI provided **operative guidance for planning and conducting such a search**. The process structure allowed a step-wise application as well as a start in a specific step if some steps were already executed in a previous project. The initial analysis of current stakeholders and intended OI partners helped the OI team to **reflect the current state and the target state** of the search. In addition, the associated discussions ensured a homogenous knowledge level within the department-spanning OI team and explicate implicit knowledge of single persons. In this respect, the **stakeholder map** was perceived as beneficial by the OI team as it offered a graphical tool that structured stakeholders, the stakeholder identification process and highlights critical stakeholders and dependencies. Nevertheless, with a growing number of stakeholders and dependencies, it is difficult to maintain comprehensibility and manageability – which was one of the reasons to develop the respective software demonstrator (cf. chapter 7.1.3). The **search field matrix** evinced as valuable basis of a systematic search by deriving distinctively defined search fields. These can be delegated to different members of the OI team allowing parallel searches. The evaluated matrix dimensions were beneficial but showed an overlap to the process phases. Therefore, operative partner criteria were derived as alternative dimensions for the following OI projects. The **search method profiles** gave an overview of the most relevant properties of methods and allowed a discursive selection.

The **anonymised approaching** of the favoured OI partners by the academic team around the author as **neutral facilitator** was seen as an important benefit by the company as it allowed to evaluate the capabilities of the OI partners in detail but without revealing the searching company. This facilitator role can be fulfilled by other cooperating institutes or commissioned OI intermediaries for future OI projects. In this respect, an important success factor is a precise definition of the problem, required capabilities and properties of the OI partners and a consistent story that the neutral facilitator can use for contacting potential OI partners. The success of the final approaching of OI partners was higher when a specific contact was known. In the successful case, a specific contact had been identified at the trade fair. Without a specific contact, the response rate was low. Therefore, to increase the general success of approaching new OI partners, a **specific contact needs to be identified** within its organisation, for instance, via phone calls at the headquarter or social media platforms.

In addition, this evaluation case study revealed **three major challenges** of the SOI methodology. Despite contrary concerns of the company in the beginning, a **large pool of potential OI partners** could be identified. Managing them along with a multitude of known stakeholders evinced to be difficult. While this primarily means the complexity of dependencies and analysis effort for known stakeholders, for new potential OI partners, it is particularly the effort of assessment. In this respect, the use of different criteria categories (cf. KANO) and step-wise evaluation proved to be beneficial, i.e. performance criteria are only assessed when an OI partner fulfils all basic criteria. Still, **access to reliable information** to assess known stakeholders and particularly new potential OI partners is a great challenge. The lack of information increases the evaluation effort as well as the risk of missing out on relevant OI partners. Partly it is addressed by defining basic criteria, which are easily assessable. However, it is necessary to identify additional company-specific knowledge sources. For instance, supplier databases can be used to enable and to evaluate specific assessments. The **definition of appropriate OI partner criteria** also evinced to be challenging for inexperienced OI teams. On the one hand, they need to be broad enough to allow the identification of new potential OI partners. On the other hand, criteria need to be distinctive for an efficient evaluation of the OI partners' relevance to the OI project. As OI partner criteria generally only describe the most relevant properties of an OI partner, it is essential that the OI team intensively discusses the derived OI partner rankings concerning (implicit) constraints.

Although this case study confirmed the applicability and benefit of SOI and particularly of the OI partner search methodology, it was strongly supervised and partly conducted by the academic team around the author. Although this allowed profound insights into the methodology's application, an **autonomous use by the OI team** of the company could not be evaluated. This was due to the fact, that the development and evaluation of the methodology were often done in parallel. Hence, the two following evaluation case studies focussed more on autonomous use by the companies.

The general **feedback from the company was positive** as SOI provided valuable benefits (cf. feedback questionnaire in appendix 13.9.1). The main aspects are a comprehensive presentation of OI and OI methods, which allows a profound impression of possibilities and limitations of OI for unexperienced companies. Although OI still requires comprehensive internal preparations, SOI offers valuable support for a systematic planning process. It helps in breaking up and leaving traditional search fields with the usual suspects. The utilisation of different search methods and adaptions generated a large pool of new hitherto unknown potential OI partners. In some cases, SOI also helped to update the knowledge about existing stakeholders that hat started activities in new technologies and market fields. Thus, the company stated: "*We consider OI as a solution strategy with high potential for future problems.*"[32]

8.3 Developing a technical solution for building technologies

8.3.1 Characterisation of company and Open Innovation goal

The second evaluation case study was in cooperation with a family-owned SME, which is a leading manufacturer of building technology products. The company focusses on quality leadership and has an average durability of strategic decisions of 5 to 10 years. The produced

[32] Original citation in German: „*OI sehen wir für zukünftige Problemstellungen als mögliche Lösungsstrategie mit großem Potential.*“

facility equipment is a mechatronic system comprising the mechanical parts and supporting electronic and software parts for controlling reasons. The products are bought by B2B customers but subsequently used by differing B2B and B2C users. This complicates direct user feedback concerning specific features and shortcomings of the product.

The focussed innovation object, i.e. the system, is installed outdoors and needs to withstand high loads and weather effects. The system is offered in different variants and versions on the market. Hitherto, the system suffers from a differing quality of its central component – even for identical products. This quality problem has been known for circa 30 years in the industry sector, but varies in its extend, occurs randomly and has not been able to be tracked down to specific product and production parameters. In the past, the company had already tried a variety of approaches to identify the specific sources and solve the problem by adapting the central component of the product. There are only a few suppliers worldwide that produce this component and that were also involved in the problem solving process. Nevertheless, the motivation of the suppliers is limited to change this component. It represents a mass-produced good, which is used by everyone in the specific industry sector and causes the same quality problems. Therefore, the company stated a regarding solution of this problem could be considered as a kind of *Holy Grail* for the industry sector and a unique selling point.

The resulting goal of the OI project was a better understanding of influencing factors, and the development of basic ideas and product concepts to improve the central function of the system. The available manpower and budget of the OI project was negotiable. Since it has not been possible to find a solution with existing partners of the company, the OI project particularly focused on collaborating with new, hitherto unknown OI partners. The need of secrecy was rated as high due to the strategic relevance of a potential solution.

In general, the company had already a long experience in collaborating with external partners, such as customers, suppliers and universities. Although they did not name and consider it accordingly, they already had conducted a cross-industry collaboration as another system's component was adapted from a neighbouring industry sector. The general attitude of internal stakeholders concerning external collaborations was rated as neutral.

8.3.2 Application of SOI methodology

In the beginning, the core OI team was set up, comprising the manager and an engineer from the advance development department, an R&D engineer from the specific department and an expert from the purchasing department. This core team was purposefully and temporally enhanced by other experts for specific phases and steps of the SOI methodology.

In the first phase, the situation analysis was conducted by involving additional experts from the controlling and human resources departments. The central aspects were presented in the previous chapter. Nevertheless, the analysis of the OI goal revealed that the system was too complex for an intuitive treatment – despite its initially perceived simplicity. Therefore, a detailed problem analysis was conducted.

Problem analysis

As the problem could not clearly be classified as incremental or radical innovation (cf. chapter 7.2.4), the OI team decided to use a hybrid model that combined components and functional modelling to analyse the technical system. This allowed to identify and analyse central components, useful and harmful functions as well as their dependencies. The model also comprised *graphically enhanced TRIZ function analysis* (MUENZBERG et al. 2014), i.e. the placement of components and functions on the respective elements in a photo or drawing of the system increases the comprehensibility for the method users. Figure 8-4 illustrates the hybrid model, which uses the photo of another product due to confidentiality issues. It depicts components and the useful functions, which they fulfil, as well as harmful functions, which are caused by useful functions. This detailed analysis derived one central component, one useful function and two harmful functions that were in the focus of the subsequent OI project.

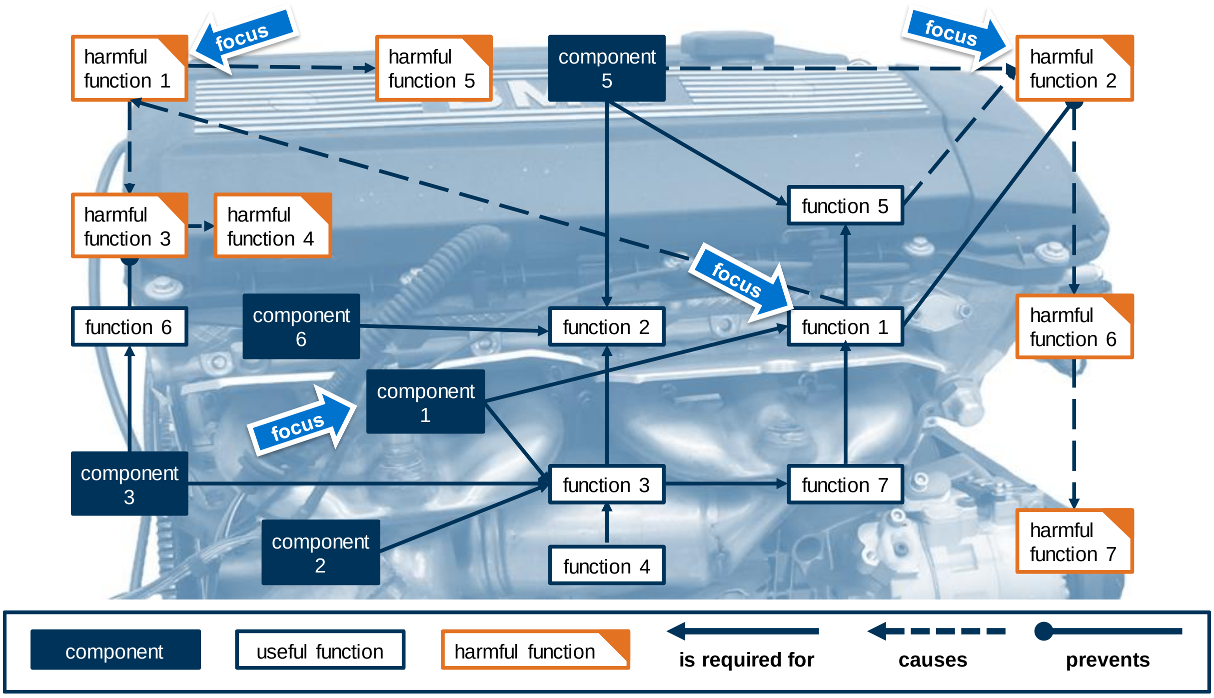

Figure 8-4: Combined component function model (anonymised and using another technical system)

Selecting Open Innovation partners

Based on the results of the problem analysis, the operative OI partner criteria were derived. An occurring challenge was an appropriate definition of these criteria: on the one hand, they needed to be quite specific to allow a profound assessment of the OI partners' capabilities. But on the other hand, they needed to be unspecific to ensure a broad search and identification of new OI partners. To allow both, the OI team defined two linked sets of OI partner criteria: search criteria and assessment criteria. In the beginning, the **search criteria** were directly derived from the hybrid component-function model. Their broad definition focus particularly on identifying new OI partners, for instance, experience or expertise to avoid the harmful function 2. As the search criteria evinced to be too unspecific for the subsequent differentiated evaluation of identified potential OI partners, additional **assessment criteria** were defined more narrowly to ensure a concrete evaluation and ranking of potential OI partners. They were also clustered in basic and performance criteria. Due to the high strategic relevance of a solution of the problem and the company focussing on new OI partners, the **two basic criteria** were: (B1) ***being no competitor***, and (B2) ***being unknown to the company***. The **six performance criteria**, their specifications scales and regarding numeric scales were: (P1) ***geographical location*** (*international [1]*, *EU [3]*, *Germany [5]*), (P2) ***language*** (*others [1]*, *English [3]*, *German [5]*), (P3) ***product knowledge*** (*none [1]*, *user [3]*, *expert [5]*), (P4) ***durability of products*** (*low [1]*, *medium [3]*, *high [5]*), (P5) ***resilience of products*** (*low [1]*, *medium [3]*, *high [5]*), and (P6) ***vertical range of manufacture*** (*low [1]*, *medium [3]*, *high [5]*). The numeric values of the specification scale are linear but using a larger delta between the steps to allow a better differentiation in the following assessment.

Along with the operative criteria the following **strategic partner criteria** were defined, which also uses a spread linear value scale (*none [0]*, *low [1]*, *medium [3]*, *high [5]*): (S1) ***power***, i.e. influence on other stakeholders, (S2) ***legitimacy***, (S3) ***urgency***, (S4) ***frequency of cooperation*** (a company focus for external stakeholders and an OI team focus for internal ones), and (S5) ***relationship / attitude*** (*positive*, *neutral*, *negative*).

Subsequently, **existing internal and external stakeholders** of the company and the OI project were identified. Within a workshop with the core OI team (cf. chapter 7.1.2), relevant innovation process phases and stakeholder classes were defined, and a first set of stakeholders for each class as well as dependencies were identified. The paper-based stakeholder map was digitalised after the workshop and evaluated by the OI team, i.e. stakeholders and dependencies were enhanced or modified. Figure 8-5 depicts the resulting anonymised stakeholder map.

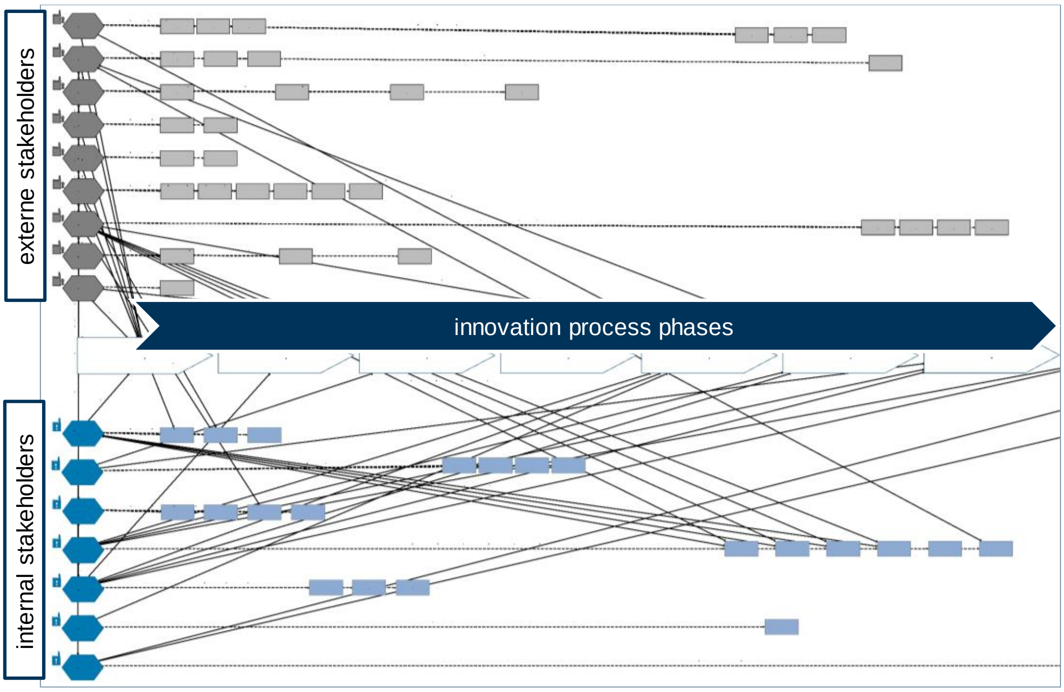

Figure 8-5: Stakeholder map of the technical system manufacturer (anonymised)

In the **second step** of the OI partner search, the existing stakeholders were **initially assessed** concerning the strategic OI partner criteria. The operative assessment criteria were not evaluated since none of the stakeholders fulfilled the basic criteria of *being unknown to the company*. This also stressed the inherent need of searching for new OI partners. The respective **search field matrix** combined the dimensions of the innovation process phases and the operative OI partner search criteria, based on the insights from the first evaluation project. To derive promising search fields, the known stakeholders were evaluated concerning the broad search criteria and accordingly mapped onto the matrix cells, as illustrated in Figure 8-6. A discursive evaluation of the large blank area in the upper right corner of the matrix revealed underlying technological reasons of these empty field. In the end, three search field were derived for the production phase[33]: (1) *replacing component 1*, (2) *improving the useful function 1*, and (3) *avoiding the harmful function 2*. In this respect, the search focus was particularly on potential OI partners from other industries as they were likely to have no existing link to the company.

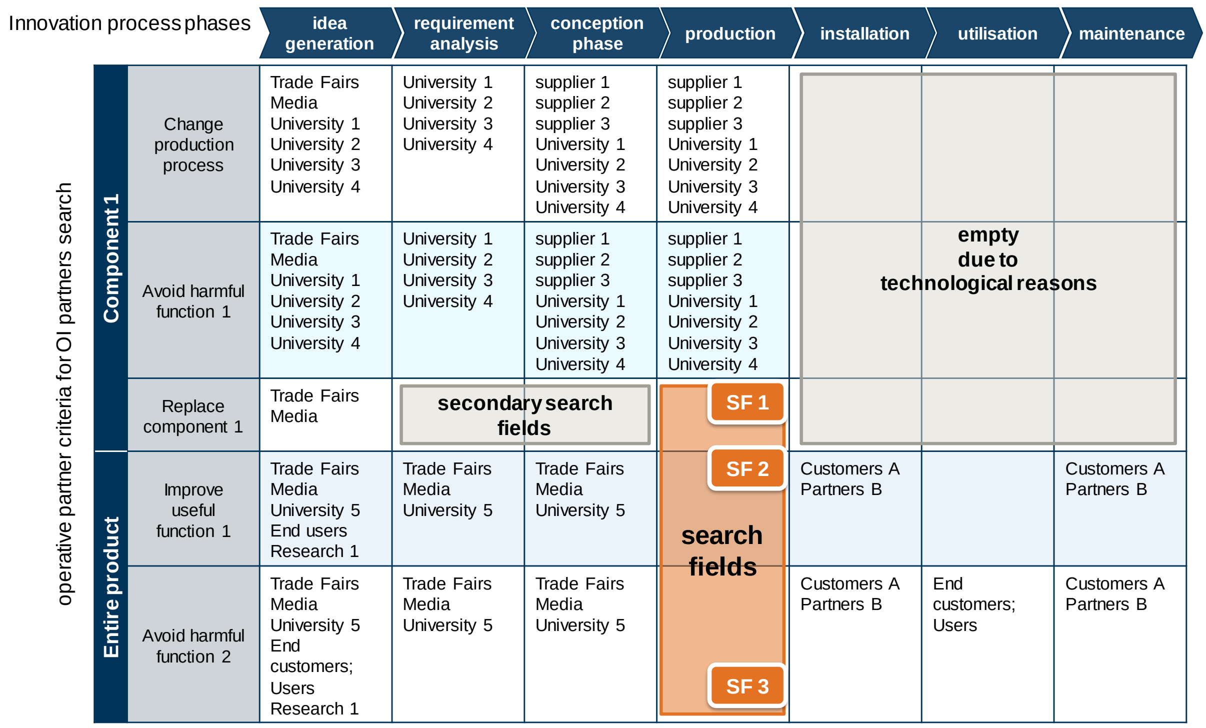

Figure 8-6: Search field matrix with highlighted search fields for identifying technical problem solvers

The three search fields were used as frame for the actual search in the **third step**. The search was sub-structured into two steps: **firstly**, identifying alternative manufacturing technologies of the central component 1, and **secondly**, searching for specific potential OI partners for each technology and search field. The search mainly used a combination of the search methods *searching* and *pyramiding*. By a media-based search on online search engines and supplier portals, potential OI partners were identified as well as interesting trade fairs. Their respective websites provided indications for further potential OI partners. The OI partners themselves were companies as well as universities and research institutes.

[33] While *fasten component 1* could be an exemplary useful function, *damaging component 1* could be an exemplary harmful one.

The OI partner assessment in the **fourth step**, was iteratively conducted in combination with the search in the third step. It used the sharpened operative OI partner assessment criteria from the first step. In total, circa 55 potential OI partners were identified and assessed. The assessment effort was quite high as the main information sources were the websites of the OI partners and complementary media articles. An analysis of strategic OI partner criteria and dependencies to existing stakeholders was not possible due to the lack of existing contacts and experience with these new potential OI partners.

Therefore, existing stakeholders were primarily evaluated concerning their strategic relevance to the success of the OI project, while new OI partners were assessed concerning their operative potential for solving the defined problem. Hence, all actors of both groups were concentrated along the y-axis respectively the x-axis of the *Strategic-Operative Portfolio*. Using the adaptable character of the methodology, the portfolio was split into two bar charts to allow a more differentiated view onto both groups.

Figure 8-7 illustrates the ranking of the newly identified OI partners concerning their **operative potential**. This was the basis of a discursive selection of (in this case) the favoured TOP-8 OI partners by the OI team. The OI team principally stuck to the ranking but intensively discussed the top ranked actors due to the proximity of their scores. The OI team replaced two from the TOP-8 partners by the ones from the ninth and tenth place: in one case, this allowed the access to a larger variety of knowledge as two TOP-8 partners had the same technological background and position the in supply chain. In the other case, two TOP-8 partners were identified as mutual competitors. Replacing one of them, ensured a positive collaboration atmosphere and resultant free exchange of knowledge, without OI partners being concerned that one of their competitors might misuse their revealed knowledge. Due to the similar scores, the remaining actors of the top-ranked group were documented as backup OI partners.

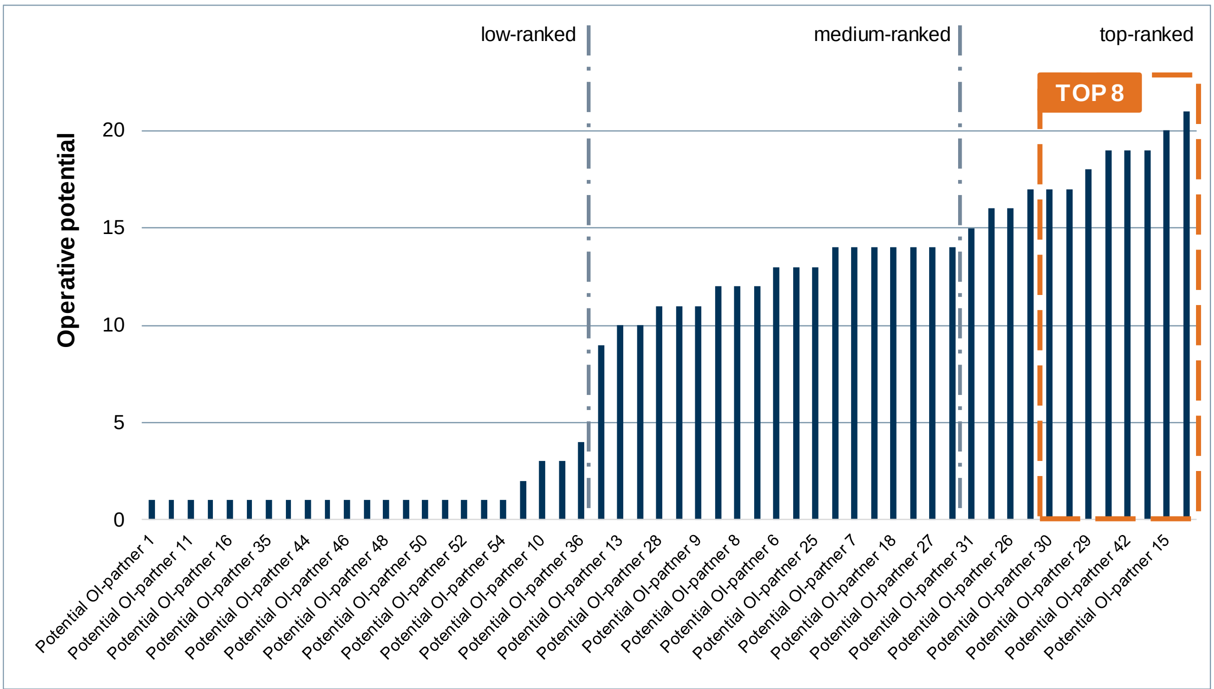

Figure 8-7: Ranking concerning the operative potential of OI partners

Figure 8-8 shows the ranking of existing stakeholders concerning their **strategic relevance**. This allowed the derivation of the following primary strategic OI partners for the OI project. In this respect, the OI team focussed on the involvement of OI partners from different departments to ensure a broad support. Along with the legal department for setting of non-disclosure agreements (NDA) with external OI partners, internal OI partners were *experts of the advance development department*, of the *focal speciality department*, of the *purchasing department*, of the *sales department*, of the *manufacturing scheduling department* and the *head of the R&D department*. For the medium-termed operationalisation of the gained OI input, additional future strategic OI partners were derived, i.e. *experts of the production*, *operations scheduling* and *quality management*.

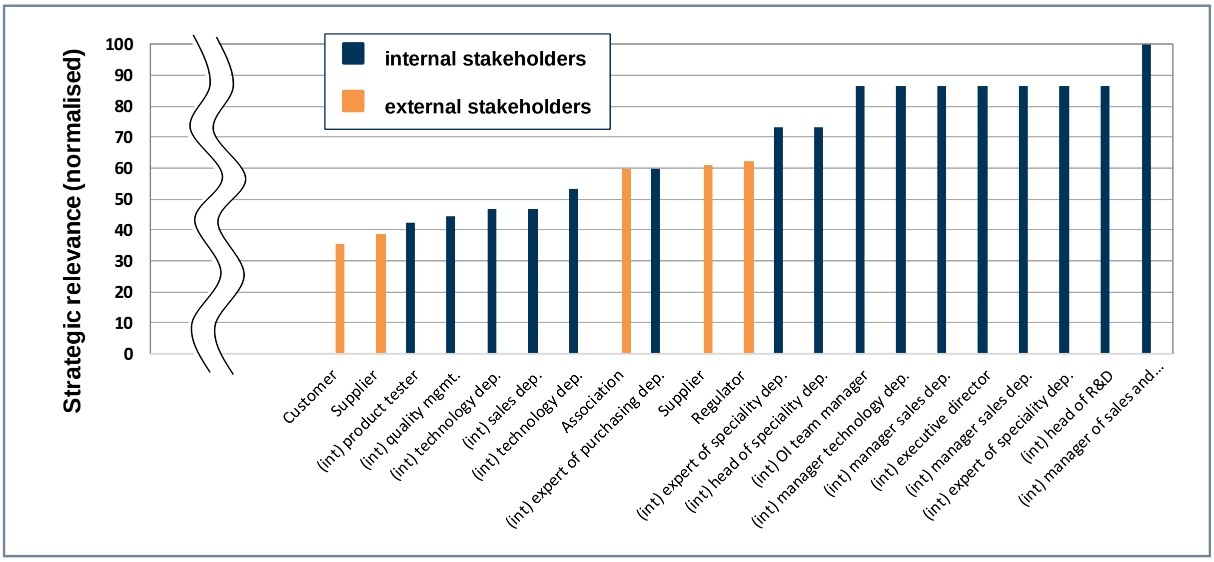

Figure 8-8: Ranking concerning the strategic relevance of known stakeholders

The identification of suitable involvement paths in the **sixth step** was based on the suitability rankings of the OI method selection tool of SOI-3. To avoid potential resistance of internal stakeholders, the OI team decided to involve the strategic OI partners also operatively into the problem solving process. The underlying idea was to use their expertise as well as to ensure their support by involving them and giving them the feeling that the solution was partly theirs and not anything alien.

Selecting and adapting Open Innovation methods

Due to similar characteristics, the TOP-8 OI partners could be clustered for the OI method selection process. The resulting five favoured operative OI partners were inserted into the **OI method selection tool** along with the existing results of the OI situation analysis. Figure 8-9 shows the OI method ranking concerning their suitability for the OI situation, which was subsequently discussed within the OI team. This revealed that the first ranked Lead User approach was not applicable since the company had no direct contact to their users, and the problem was too specific for normal users. Broadcasting was not suitable due to the high need of secrecy as indicated by exclusion criteria. Therefore, a combination of university and cross-industry cooperation was selected, which fitted to the mixed academic and industry background as well as the industry-spanning background of the selected OI partners. Toolkits (late phase) were not suitable due to a missing mass customisation focus of the OI project.

Score	OI method
51	Lead-User approach
41	Broadcasting
37	University cooperation
36	Cross-Industry-Innovation
36	Toolkit (late phase)
32	OI intermediary
32	Communities for OI
23	IPI
15	Toolkit (early phase)
13	Netnography
4	Ideation platform
0	Ideation contest

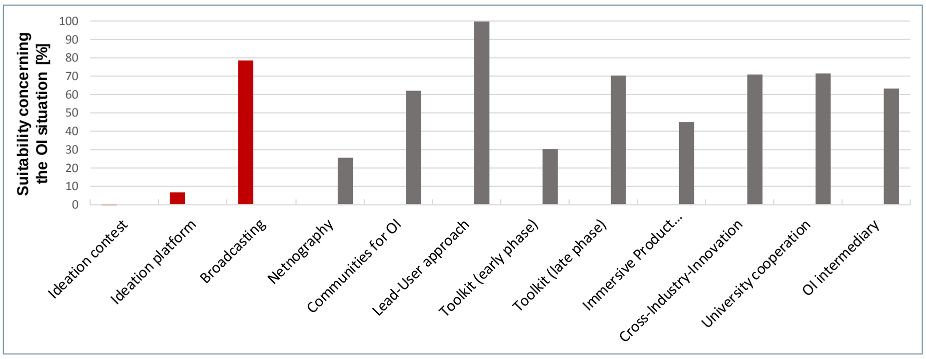

Figure 8-9: OI methods' suitability concerning the OI situation

These selection was additionally supported by the results of the OI situation-partner portfolio ranking. As shown in Figure 8-10, the two selected OI methods are suitable for all favoured OI partners. However, the detailed trigger and exclusion criteria analysis revealed a low motivation as criterion of exclusion for the second OI partner. However, after discussing this, the OI team agreed on monitoring but principally involving the second OI partner due to the subjectivity of the assessment of the specific criterion.

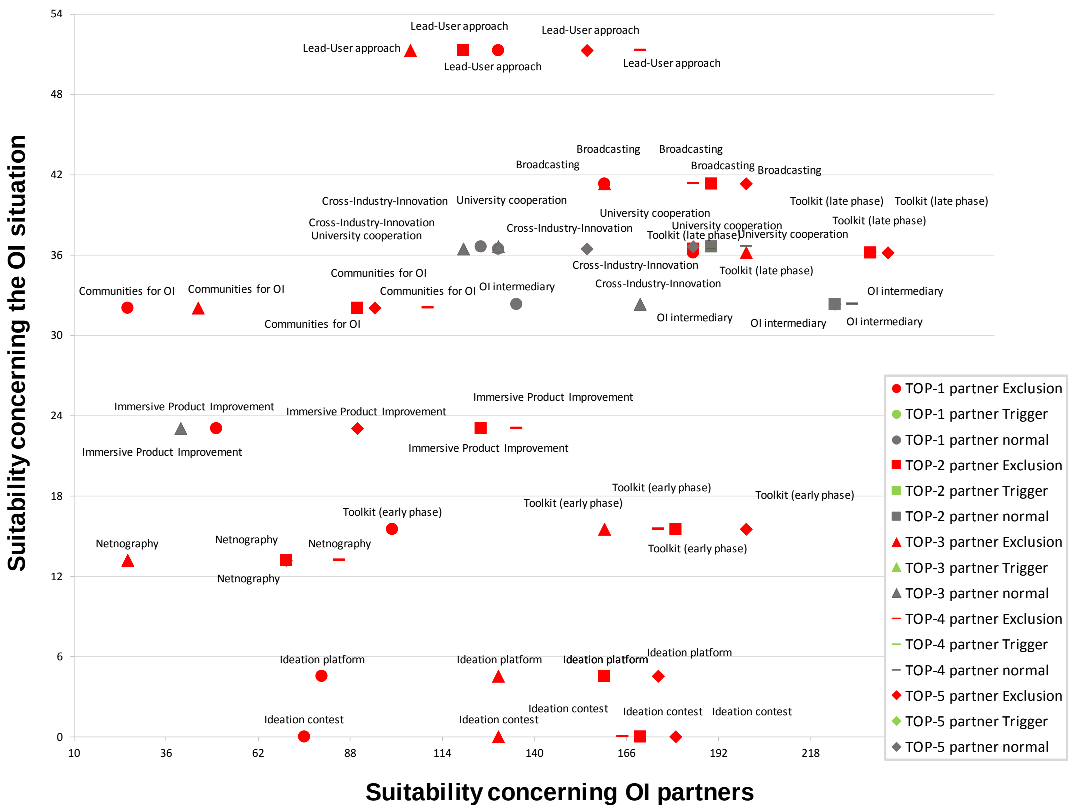

Figure 8-10: OI method portfolio concerning fit to OI situation and favoured OI partners

Based on the selected OI methods, i.e. a cross-industry workshop and university collaboration, the OI team set up the group of involved OI partners as indicated in the previous section. The group should comprise an equal amount of external and internal OI partners. To allow the use of synergy effects but avoid negative effects of a too large group, the **group size** was set to 16. This meant an involvement of the TOP-8 operative external OI partners and the eight most relevant internal OI partners.

Planning the Open Innovation project management

Based on the ranked list of potential OI risks (cf. chapter 2.3.4 or GUERTLER et al. (2015d, p. 6)), the OI team discursively chose a workshop as specific form of the cross-industry collaboration to prevent uncontrolled knowledge drain by a non-public involvement and using non-disclosure agreements (NDAs). In addition, wrong decisions when planning and executing the OI method were seen as major challenge due to the missing experience with the specific characteristics and barriers of cross-industry collaborations. In particular, motivating OI partners from different industries and company cultures to join the workshop and to actively contribute within the workshops was a challenge. In terms of an insufficient organisation of the workshop, there was the risk of the company of losing reputation if the participants might have complained in public afterwards. Therefore, the OI team decided to commission an additional OI intermediary to support in planning and moderating the workshop, which was also in line with the results of the OI method selection tool. This also allowed to use their experience in formulating NDAs and terms of use of developed ideas and concepts. As performance metrics the number of developed solution ideas and aggregated concepts were defined for the workshop.

Planning the Open Innovation project in detail

The detailed planning was conducted in cooperation with the OI intermediary. To find a suitable one, the OI team identified alternative **OI intermediaries** that had experience with OI, workshop moderation and in particular with cross-industry collaborations. Within the acquisition process, the OI team's experience with the SOI methodology supported in evaluating the specific service offers. For instance, one intermediary tried to sell its standard service package without meeting the specific needs of the company. In the end, the OI team could identify and chose an OI intermediary, who offered a workshop concept, which was specifically adapted to the scope and needs of the OI project.

In respect to **acquiring the external OI partners** for the cross-industry workshop and approaching them appropriately, the OI team used the information from the OI partners' assessment step and extended it by information from the homepages of the OI partners as well as from social media and media articles. In half of the cases, this allowed to identify specific contact persons within the organisations. Otherwise, the OI team phoned the respective head office and asked for suitable contact persons. The first contact was established via telephone. This allowed a detailed explanation of the OI project, its purpose and boundary conditions, as well as a first subjective evaluation of the motivation of the OI partners. Subsequently, the OI team sent an email with detailed information to the interested OI partners, including a deadline for a positive or negative answer. Nevertheless, the OI team called up the OI partners again to demonstrate the company's interest in involving them. However, the OI partners were not specifically motivated, for instance, in the case of no reply. They also did not receive any compensation for their participation in the workshop. This should ensure a sufficient intrinsic motivation of the final workshop participants.

The **acquisition of academic OI partners** proved to be difficult: two institutes were interested but already occupied for the dates of the workshop. Others could not see a link to their research areas or demanded a financial compensation for their participation. In this case, the **backup list of ranked alternative OI partners** was beneficial to replace these primarily favoured academic OI partners. Nevertheless, the OI team also used this unintended chance to purposefully search for additional OI partners by utilising the search field matrix. They focussed on a particular supply-chain stage, which had been only ranked as secondary in comparison to academic OI partners. Due the strategic support of the head of the specific R&D department, the **acquisition of internal OI partners** was relatively effortless. This acquisition process also awoke the attention of one of the executive directors, who stated his interest in participating himself. After discussing the positive and negative effects onto the dynamics of the workshop group, the OI team decided to invite him, to increase the strategic support of the OI project and following activities.

In respect to the setup of the workshop, the OI team set its duration to 1.5 days – as a compromise of sufficient time for developing solution concepts and temporal effort of the participants. The location was a remote hotel to ensure an undisturbed and focused work of the OI partners. To increase the understanding of the technical problem, the OI team organised **illustrative test materials** for each OI partner. Due to being a mass-produced good, this was possible without serious expenses.

The OI partners were provided with **general information** about the company, the goal and purpose of the OI project and the workshop, the group of participants, the agenda and location, and the bearing of travel and hotel costs by the company. A particular monetary compensation for participating was not paid. Instead, the non-monetary **benefits of the participation** were stressed: (1) an active contribution to the development, optimisation and evaluation of innovations, (2) getting known to specific creativity methods to support the development of innovations, and (3) networking with companies from neighbouring industries and identifying potential future business partners. Each OI partner had to sign a NDA and terms of participation beforehand. These clarified that (a) all developed ideas and concepts would need to stay secret until a specific date, (b) the company had the right to document, save and further develop all ideas and concepts of the workshop, and (c) use them for collaborations with specific participants, while (d) these further collaborations need to be arranged separately. Explicitly excluded were information that were publicly known or state of the art.

In cooperation with the OI intermediary, the OI team specified the particular tasks of the workshop. Based on the identified search fields from SOI-2, three **problem areas** (*materials, mechanism and function, optic and shape*), each with three to four specific **search questions** were defined (for instance: “*How can we change the mechanics to allow a reproducible useful function 1?*”). To increase the understanding of the OI partners for this primarily unfamiliar problem, the OI team decided to provide the previously mentioned illustrative component samples to each workshop participant.

Executing the Open Innovation project

In the following an overview of the workshop is given. The group of active participants comprised eight internal and eight external OI partners. In addition, the head of the OI team participated as host, who only observed the workshop but did not actively collaborate. The team of the OI intermediary comprised a moderator, a minute taker and an illustrator for visualising ideas and concepts.

The workshop itself was split into two days, similar to ENKEL AND HORVÁTH (2010, p. 306) but with a four hours session on the first day and an eight hours session on the second day. On the first day, along with a general welcoming of all participants, the company and the technical problem as well as the methodical framework and code of behaviour for the workshop were explained. For instance, to foster creative and unconventional ideas, the participants were invited to deliberately overcome mental barriers of experience, habits and rules, as well as to avoid so called *killer phrases,* such as "*no*", "*we have always done it like that*" and "*yes, but*". To directly trigger this unconventional way of thinking, and contrary to usual workshops, all participants had to graphically introduce themselves by drawing and presenting their background, company, motivation and expectations towards the workshop.

Subsequently, the first group work started with four sub-groups and four participants each. By using the method of **negation** (cf. LINDEMANN 2009, p. 202), each sub-group selected one search question from a particular problem area, negated it and tried to find solutions for this contrary task. The resulting ideas were transferred back and adapted to the original problem, and documented in specific idea forms.

The end of the first day was a common dinner, where all participants could get known to each other in a relaxed atmosphere, deepen discussions from the first group work session and build the basis of a trustful collaboration for the following day.

The second day started with a **stimulus analysis** group work (cf. LINDEMANN 2009, p. 144, 153). Each of the four sub-groups (with newly mixed members) selected one search question of a problem area. In the following, they were successively supplied with five different pre-defined company profiles, which described large successful companies with distinctive characteristics. These were stimuli for each sub-group for developing solution ideas by adapting these characteristics. For instance, IKEA was characterised by a modular product architecture, standardised components and an outsourcing of assembly steps to their customers. Another stimuli session utilised different sensorial perceptions as trigger for new ideas for a specific search question, such as random pictures, haptically feeling out objects in a bag and analysing natural objects. The individually perceived object's properties were transferred to the search question to derive creative solution ideas. In addition, by using the method **problem abstraction** (cf. LINDEMANN 2009, p. 141), each sub-group got profiles of different pre-defined working principles, such as *lotus effect* and *laser beam cutting,* which were then adapted to a search question. Figure 8-11 illustrates a group work session of the second day.

The results of the ideation part were circa 250 developed ideas. These were aggregated to solution concepts. Using the method of **scoring** (cf. LINDEMANN 2009, p. 73), the participants could assign up to seven points to their favoured ideas. The resulting eight ideas with the most points were *central ideas*, the rest were *supporting ideas*. Each of the four sub-groups got two central ideas and enhanced them by different supporting ideas to initial solution concepts. In the following, one team member of each sub-group took the concepts and presented it to another sub-group. There he defended it against critical feedback and improved it accordingly. Insufficient concepts were filtered. In the end, four promising concepts were derived, which need to be further concretised and developed by the internal R&D department. Therefore, the defined goal of the OI project was successfully reached from the perspective of the company.

Figure 8-11: Impression from the cross-industry workshop (anonymised)

8.3.3 Discussion of case study and results

The evaluation of the SOI methodology and direct feedback from the company (appendix 13.9.2) revealed a high effort of the first application of SOI but which will decrease for following applications due to learning effects. During the first utilisation, relevant internal contacts could be identified, who are also relevant for following OI projects. In any case, stating the benefit of the entire methodology as well as single elements was crucial for the acceptance and use by the OI team and other internal stakeholders. The latter were important as operative support for the OI core team in single phases and steps of the SOI methodology, for instance, for the OI situation analysis, stakeholder analysis or OI partner search. This allows a need-specific personnel management.

In respect to the stakeholder analysis, a combination of an initial workshop with in an extended group and a post processing by the core OI team proved to be appropriate. This allowed to use the expertise and perspectives of different actors for the identification of relevant stakeholders and dependencies, and hold the possibility to evaluate and concretise particular aspects afterwards. A major challenge remains the selection of an appropriate level of detail, but which should get easier with an increasing experience with the methodology. As the evaluation case showed, for some OI projects it makes sense to differentiate OI partner criteria in **criteria for searching** and **for assessing** potential OI partners. The first ones are defined more broadly and allow the identification of a large pool of actors, while the second ones are defined more narrowly and allow a distinctive differentiation of relevant OI partners. The subsequent setup of the **search field matrix** and definition of search fields was rated as time expensive by the industry partner but as essential for a correct focus of the OI project. It also facilitates the distribution of parallel search tasks to different OI team members or delegation to other actors. The evaluation also proved the adaptability of the methodology, for instance, by applying a hybrid problem analysis model or differentiated rankings of strategically and operatively relevant OI partners.

Due to its specific expertise with cross-industry workshops, the execution of the workshop was **delegated to an OI intermediary**. Based on the results of the applied SOI methodology, the company had a **clear scope of activities to delegate**. According to the company, the experience from SOI also allowed a profound evaluation of different service offers and exclusion of insufficient ones. The finally selected offer was less than half the price of the first offer but individualised to the specific needs of the company.

The qualitative evaluation of the motivation and expectations of the workshop participants during the introduction part of the workshop yielded the following motives, which can be used for future workshops: The most important reason for internal and external participants was learning **new methods for solving problems** and developing creative ideas. This was directly linked to **developing a solution for the given problem**, which however was more important to the internal than the external actors. The latter focussed more on learning about **topics neighbouring their field** of expertise and about **product requirements of their indirect customers** as well as getting in **contact with potential new customers**. **Networking** in general was stated as motive from both groups. A minor issue on both sides was **getting general inspiration** for developing completely unconnected ideas for other, individual problems.

The general feedback of the company was that SOI allows an easy access to OI by proving a systematic approach for analysing the problem, the stakeholders and collaboration methods. The methods and tools of SOI were rated as intuitively and easily usable along with a quick learning curve. The methodology was seen as guiding frame, which also allows individual adaptations. For instance, splitting the Strategic-Operative Portfolio in its two dimensions facilitates a differentiated evaluation of relevant strategic and operative OI partners. The cause of only internal costs was stated another benefit, although costs for the execution of the OI project need to be considered as well. The approximate distribution of time exposure was stated as 10% for the OI situation analysis, 50% for the problem analysis and 40% for selecting OI partners and OI methods.

A major limitation, was the access to reliable information to assess stakeholders and potential OI partners. The publicly available information was limited in its extend and level of detail. In this respect, the web-based search showed the advantage of being anonymous but the disadvantages of its success being directly linked to the quality of the applied search terms. It also bears a high effort of filtering unsuitable OI partners and a lack of completeness of the OI partner search. The latter requires the definition of distinctive stop criteria to avoid endless searches. Points for further improvements and research are also a more detailed consideration of measures for the long-term implementation of OI and searching for OI intermediaries for specific tasks. Nevertheless, the **overall conclusion of the company** was that "*SOI allows a systematic, interesting and motivated work that lies the basis of innovations*".

8.4 Developing a product service system for manufacturing plants

8.4.1 Characterisation of company and Open Innovation goal

The third case study was in cooperation with a SME, which designs and produces manufacturing plants and corresponding services for packaging products. This means, the company itself does not manufacture these packaging products but only its B2B customers. The SME is the world market leader for this type of machines and focusses on a quality leadership strategy. The machines are characterised by a high durability (mechanical parts up to a few decades) and a high output. However, along with high investment costs, the machines show a high consumption of operating supplies, such as electricity and water. On the one hand, these cause additional costs. On the other hand, they are increasingly regulated by new environmental laws and regulations.

In addition to the production and sale of the physical machines and spare parts, another major business area are lifecycle-spanning services for own and third-party machines. The following OI project was located within this latter area. The **superordinate goal of the OI project** was the development of a specific new service model to support customers in measuring, controlling and reducing their consumption of operating supplies. In the short-term, this service should be offered as an add-on to existing own and third-party machines. In the medium-term, this should be the basis of an integrated product service system (PSS). Using the PSS categorisation model of TUKKER (2004, p. 248), the wanted PSS was classified as **product oriented** by combining *product-related services*, and *advice and consultancy* aspects.

As the company had no or only limited experience with these specific type of services, the superordinate goal was structured into the following **sub-goals**: (1) the first sub-goal was an improved knowledge of customers concerning their requirements and expectations towards such a PSS. (2) The second sub-goal was the identification of underlying reasons and drivers, such as regulations, laws and demands of the customers of the customers. (3) As third sub-goal, additional customer needs should be identified, which are outside the primary scope of the service but would be complementary and therefore increase the customer value of the entire PSS. (4) The fourth sub-goal was the search for potential OI partners to develop such a PSS. The expected maturity level of the gained OI input was defined as ideas and concepts. The identification of new, unknown OI partners was not in the focus. On a strategic level, the OI project was located at the department manager.

The **supply chain is quite long and complex**. The company produces manufacturing machines, which their customers use to produce the basic packaging material that their customers use to produce the final packaging product, which their customers finally apply to pack their products. Therefore, the company only had a rough understanding of the specific needs and requirements of each customer level. The market environment had a **medium strong level of competitiveness**, compared to the two other case studies. The market was mainly based on mutual trust, which hinders the market entry of new competitors as well as customers frequently shifting between machine manufacturers. The resulting **level of secrecy was also medium** as others should not know about the developed solutions but could know about the OI project itself and its goal.

The OI team stated the level of the innovativeness of the service unit as "*service-specifically hands-on*". Although, the company had no particular experience with OI, it had frequent **collaborations** with academia and direct customers. During the planning phase of the OI project, the company got in contact with an OI intermediary, to develop a technical solution for another problem. As this cooperation was perceived as unsatisfactory, the OI team's attitude towards intermediaries was reserved. In addition, the general attitude of employees towards externals was considered as reserved.

From a research methodical point of view, the OI team was given an introduction to the SOI methodology in the beginning of the project planning and at the beginning of each methodology step. This included all sub-approaches, methods and tools. Except some specific method feedback, the OI team autonomously applied the methodology. In the case of any question, the OI team could contact the academic team around the author and ask for support and clarification. These queries were used as main element to evaluate the methodology along with direct feedback and the results of each planning phase.

8.4.2 Application of SOI methodology

The original OI team comprised two managers from the specialised department with different areas of responsibility and an expert from this department, who had previously worked in the sales department for some years.

Except the situation analysis (cf. previous chapter), no specific problem analysis was conducted due to the general focus of the OI project. Compared to the other two evaluation case studies, the main characteristics of this OI project were the limited experience of the company with this particular type of PSS and the medium level of secrecy.

Selecting Open Innovation partners

In the first step of the OI partner search, the OI partner criteria were defined based on the results of the analysis of the OI goal. The OI team defined **four basic criteria**: (B1) *being no competitor*, (B2) *being no service provider* (as they are competitors within the service area), (B3) *being no end customer* (too far away from the actual technical problem), and (B4) *fulfilling a specific company-internal strategic requirement*. Although, these criteria are primarily strategic, they directly affect the suitability of an operative involvement. The **six operative performance OI partner criteria** were: (P1) *experience with the specific type of manufacturing machines*, (P2) *experience in developing the specific type of service model*, (P3) *experience with the consumption measurement of operating supplies*, (P4) *experience with the definition of regulations*, (P5) *general experience with service development*, and (P6) *experience in exploiting the specific type of PSS*. Along with these, the OI team defined (S1) *power*, (S2) *interest* and (S3) *attitude towards the OI project* as **strategic OI partner criteria**.

Subsequently, the current state of potential OI partners was evaluated by the **stakeholder analysis**. Within a workshop moderated by the author, the OI team defined 11 relevant innovation process phases and 27 stakeholder classes. Based on them, they identified around 90 concrete internal and external stakeholders as well as a first set of dependencies between them. The workshop used a flipchart-based stakeholder map, which supported the visualisation and discussion of issues, and ensured a homogenous knowledge level within the OI team. Since its members had different backgrounds and perspectives, there were a couple of mutual *"aha moments"*. After the workshop, the paper-based stakeholder map was digitalised, reviewed by the OI team and modified where necessary. Figure 8-12 gives an overview of the digitalised stakeholder map.

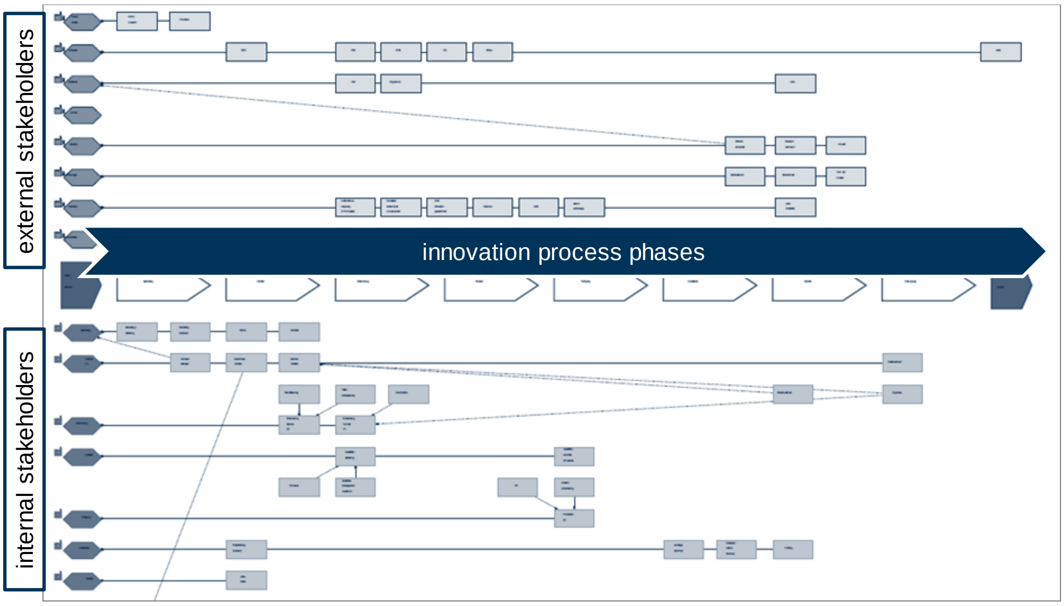

Figure 8-12: Stakeholder map of the manufacturer of production machines (anonymised)

In the **second step**, the OI team initially assessed the existing stakeholders concerning the operative basic criteria, and performance criteria if they fulfilled the basic criteria. The remaining circa 50 stakeholders were clustered in a **search field matrix** with the innovation process phases on the x-axis and the operative performance criteria on the y-axis, as illustrated in Figure 8-13. The innovation process could be differentiated in phases within the company and external phases at the customers. The matrix revealed that there were at least two stakeholders within each field. Therefore, the **OI team decided to skip the optional search** for new additional OI partners.

However, from an academic perspective, the author decided to conduct a targeted search independently from the company, to evaluate the search step of SOI. A selected search field were regulators and regulations of the use phase of the PSS due to setting the general frame and constraints of the wanted PSS. Another search field were manufacturers from other industry sectors that had already experience with such service models and integrated PSS. The focus was set to energy consumption-related topics to prevent the risk of a too broad search scope.

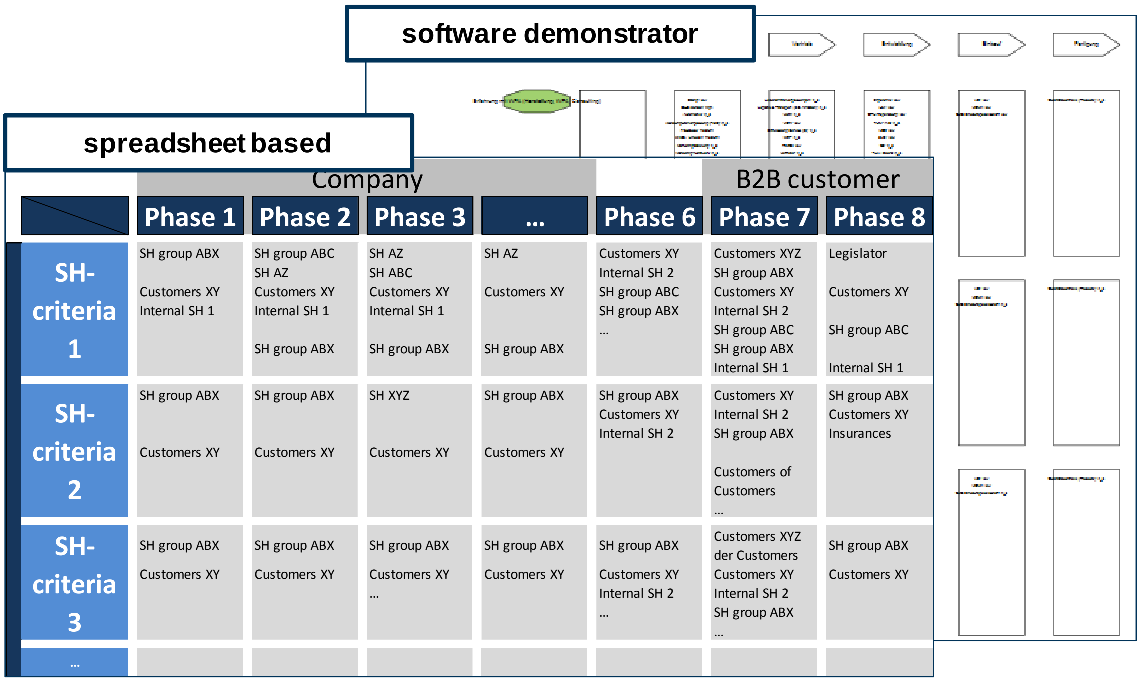

Figure 8-13: Search field matrix (anonymised)

In the **third step**, different search methods were applied. Within the first search field of regulators, a combination of an online *media-based searching* and *pyramiding* approach was applied, i.e. each intermediate result was used as starting point for subsequent search iterations. The final results were less actors rather than specific regulations and laws. Nevertheless, within a subsequent meeting with the OI team, they were rated as beneficial since they allowed a systematic overview of relevant aspect to consider when designing such a PSS.

To allow a systematic cross-industry search (cf. ECHTERHOFF 2014) within the second search field, firstly, **promising industry sectors** were identified. One the one hand, industry sectors with the highest energy consumption were identified. They were considered to have expertise in managing and reducing this consumption. On the other hand, another search path was using similarities of the production process by looking for other industry sectors with a continuous flow-production. They ranged from neighbouring sectors with similar processed materials, via automotive manufacturing, to filling plants and food production. All of these industry sectors were the basis for a **subsequent search for concrete potential OI partners**, such as individuals, companies, research institutes, and groups of them. The resulting list of potential OI partners was given to the OI team of the company, which internally evaluated their relevance and expected benefits. Due to the lack of detailed information, this assessment was conducted discursively involving additional company-internal experts from different departments. In the end, two of these actors were added to the list of potential OI partners.

In the **fourth step** and in parallel to the optional search step, the OI team assessed the known stakeholders in detail. In addition to the existing assessment of the operative OI partner criteria, the OI team also evaluated the strategic criteria. The resulting operative potential was the normalised sum of all performance criteria, and the strategic relevance the sum of all strategic criteria. Figure 8-14 shows the resulting Strategic-Operative Portfolio of all known stakeholders.

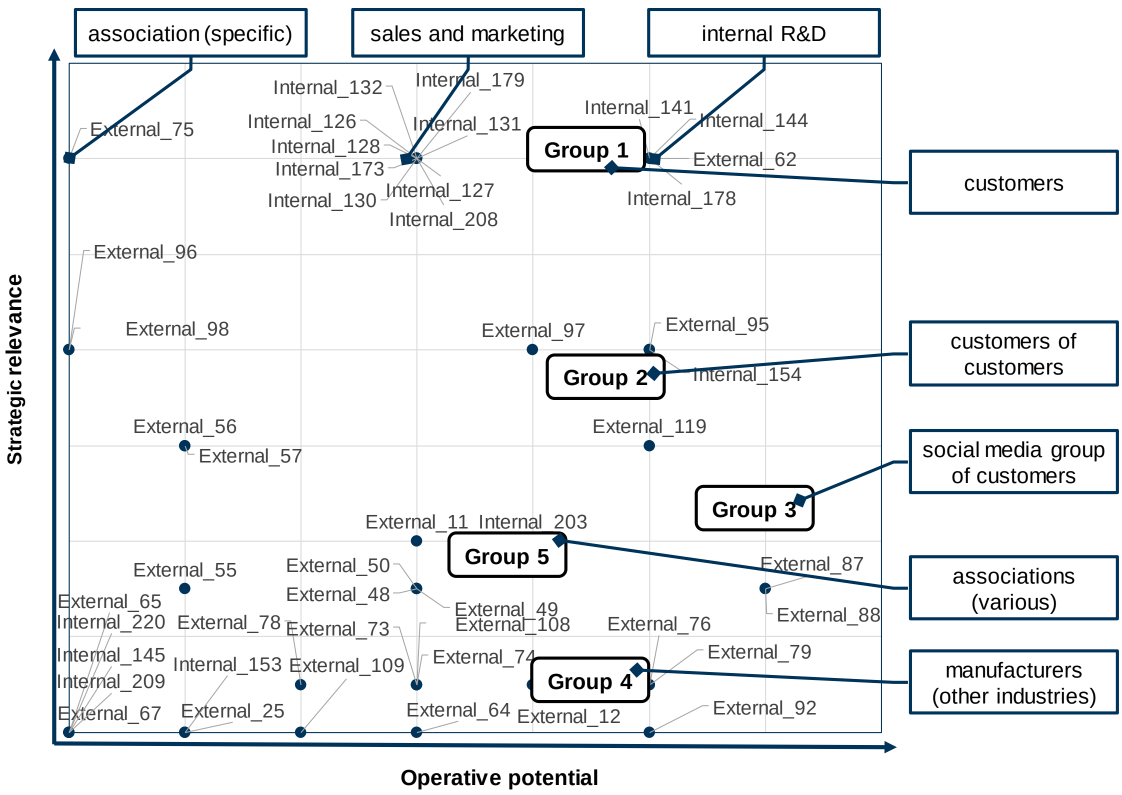

Figure 8-14: Strategic-Operative Portfolio of known potential OI partners (anonymised)

The portfolio was the basis of the **fifth and sixth step**. Using the portfolio, the OI team derived (in this case) five groups of **operatively relevant OI partners**: (1) direct external customers, (2) customers of customers, (3) a particular social media group of customers, that were discussing specific problems and solutions, (4) manufacturers from other industries, and (5) different associations. In the following detailed planning phase, those groups were roughly clustered into customers with knowledge about needs, and cross-industry manufacturers with knowledge about potential solutions. Involving both clusters allowed the analysis of intrinsic and extrinsic motives for the new PSS from a customer perspective, as well as the identification and discussion of existing similar PSS from other industry sectors. From the perspective of **strategic OI partners**, the sales and the marketing department showed the highest relevance along with a specific association.

Selecting and adapting Open Innovation methods

The favoured five OI partner groups were inserted into the OI method selection tool. As the resulting OI method ranking portfolio in Figure 8-15 shows, crowdsourcing methods are generally unsuitable due to the limited size of each OI partner group. The only exception was the social media-based group: unfortunately, the identified social media group evinced to be only temporary and had broken up by the time of the detailed OI project planning. Due to the unsatisfactory experience with the OI intermediary from the parallel R&D project and the additional costs, OI intermediaries were excluded by the OI team. Therefore, the OI team decided for a combined Lead-User and cross-industry workshop to involve both, the customer groups and the cross-industry manufacturer groups.

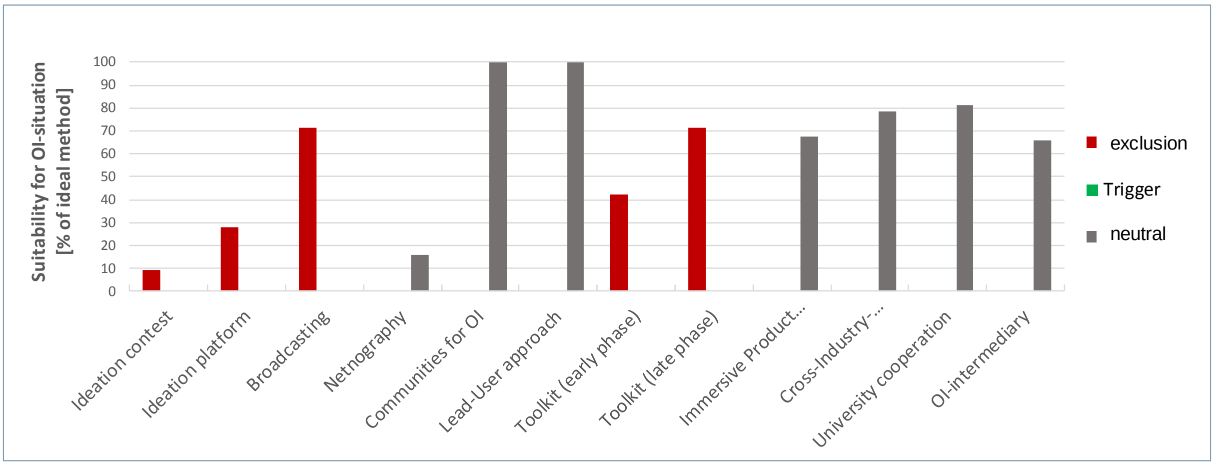

Figure 8-15: OI situation focussed Ranking of suitable OI methods

The results from the bar chart were compared with the portfolio representation in Figure 8-16, which supported the selected collaboration strategy. Nevertheless, it also indicated a university collaboration as suitable OI method. This triggered the consideration, and resulting selection of additional OI partners from academia to gain access to the current state of research, such as from manufacturing technologies or PSS development.

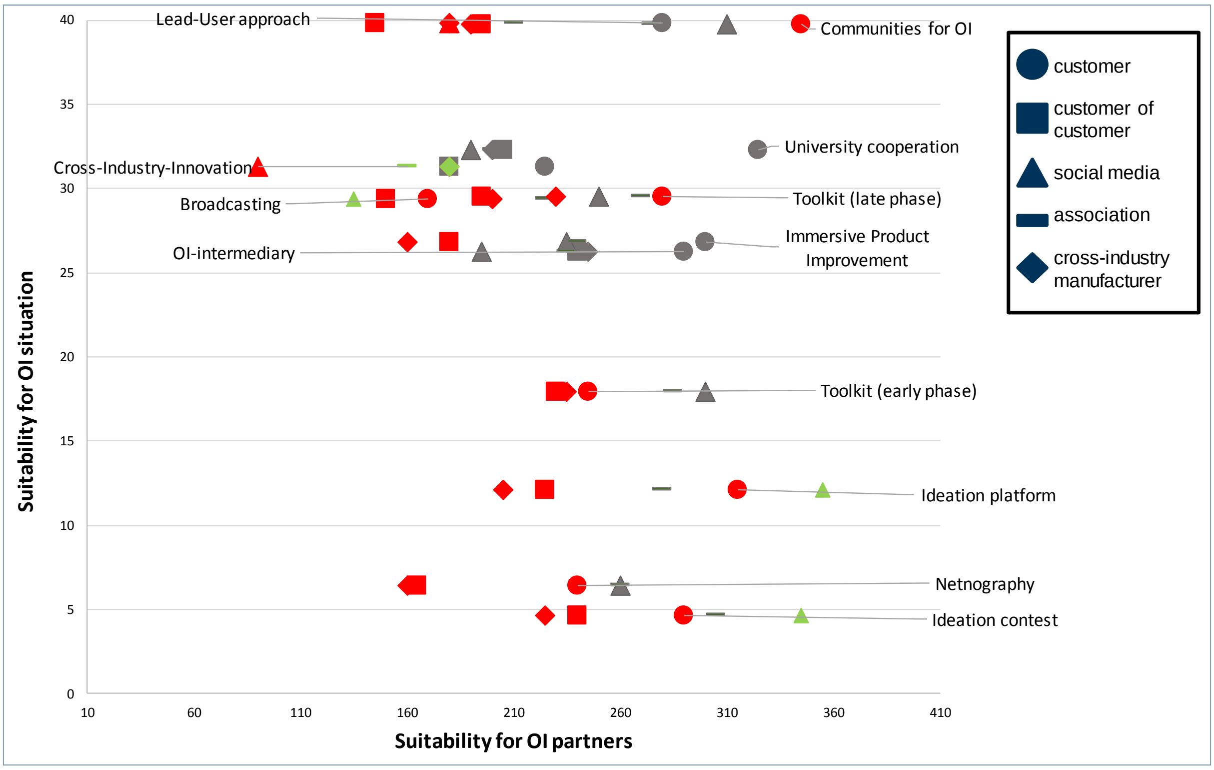

Figure 8-16: OI situation and OI partner focussed ranking of suitable OI methods

Planning the Open Innovation project management

The **change of the OI team manager** evinced as a source of general barriers. Due to an insufficient project hand-over, his successor did not identify himself with the OI project along with a lack of motivation and resistance to change. From the new team manager's point of view, insufficient decisions in OI planning had been made and the wrong OI partners had been selected. Due to the OI project strategically being only located on a department manager level, who also was the OI team manager, superordinate management support for the OI project was missing. In this respect, the **inherent documentation** of the SOI methodology was beneficial to explain the new OI team manager the purpose, process and decisions of the OI project. Based on this, the focus of the OI project in terms of OI partners and OI methods were slightly adapted.

In general, the risk analysis of the OI project was conducted using the list of ranked OI risks and barriers from chapter 2.3.4. In respect to the combined Lead User and cross-industry workshop, the OI team suggested that the academic team around the author could moderate the workshop. However, due to the lack of neutrality and routine of cross-industry workshops, the risks of insufficient workshop outcomes and a damage of reputation were rated as high.

Planning the Open Innovation project in detail

Due to the change of the OI team manager and his differing expectations and preferences, the documented planning process and made decisions were discussed within the OI team. Based on his new interpretation of the results of the stakeholder analysis and the assessment of identified new OI partners, the originally five groups of favoured OI partners were aggregated into two groups: customers and cross-industry manufacturers. These were principally consistent with the previous five groups but less differentiated. Along with this, also potential OI partners were excluded that had a perceived too high technological distance, such as automotive production and filling plants.

Although the academic team around the author decided not to moderate the workshop themselves due to the previously mentioned risks, it supported the OI team in developing a concept for planning the acquisition of participants and the setup of the workshop. According to ENKEL et al. (2009a, p. 151f), for the **acquisition**, it is essential to stress the direct benefit for each participant (such as networking, learning new design methods and meeting potential customers) and the potential analogies between the industry sectors. To define these aspects in detail, the OI team was supplied with a list of enablers and barriers of participation (ENKEL et al. 2009a, p. 151f), shown in chapter 7.6.

Independent from the **workshop concept** of case study 2, the basic workshop setup was defined as follows, orientating at ENKEL AND HORVÁTH (2010, p. 302f). The overall goal of the workshop was defined as matching customer needs and existing solution approaches. Along with the discussion of the transferability of the solution concept to the own industry, the specific customer demands should be specified, including the question if one of the other manufacturers could already fulfil particular customer needs, or if there was an actual gap. The OI team defined a maximum duration of one day for the workshop to keep the effort low for the participants. To get a better understanding of the problem, in the beginning of the workshop, customers should state their motivation and external drivers as well as their expectations towards the wanted PSS. By weighting each aspect, central problem areas should be derived. Subsequently, the other manufacturers should present their existing solutions and the addressed underlying customer needs. In the following discussion, the transferability of presented solution concepts to the own industry should be clarified as well as potential cooperation potentials with the other manufacturers identified.

However, within the **first exploratory meeting** with a manufacturer from another industry, the lack of experience of the company within the specific field of PSS evinced to be a major obstacle. Therefore, the OI team decided to postpone the workshop. Instead, the company and the other manufacturer decided for a dyadic meeting to discuss alternative fields of cooperation. This should support to get known to each other, and give the company time to gain own initial experience in the originally wanted area of PSS. Due to the lower need of secrecy, compared to the two other case studies, contacting this external OI partner was less complicated. The issue could be discussed openly and in detail, and no neutral facilitator was required (cf. CS 1).

8.4.3 Discussion of case study and results

The goal of the OI project was the development of a basis of a new PSS. Since the cooperating company had no own experience in this field, the OI project should identify OI partners for analysing the underlying drivers and requirements of such a PSS as well as first solution ideas.

The following discussion is based on the scientific observation of the OI pilot project, discussions in the context of regular project meetings and the feedback of the original OI team manager (cf. appendix 13.9.3). The evaluation case study proves the applicability and general advantages of the SOI methodology for planning OI projects in general, and for the specific challenges of the OI case study project in particular. Since the new PSS should enhance existing as well as future production machines, stakeholders of the new service, the machine and users of competitors' machines needed to be considered. The methodical **stakeholder analysis** in the beginning proved to be beneficial for deriving the current state of known potential OI partners in terms of external and internal stakeholders, and their dependencies. In parallel, necessary skills and expertise of OI partners were specified as target state by the definition of OI partner criteria that result from the analysis of the OI project's goal. Along with an operative **guidance of unexperienced OI team members**, its discursive elements also ensured a **homogenous knowledge level** within the usually department-spanning OI team. The **initial assessment** of known stakeholders allowed an evaluation if the pool of potential OI partners has a sufficient size or if new OI partners needed to be identified. Since the pool within the case study was considered as large enough, the effort of an additional search could be saved. Nevertheless, although it was not required, this additional search (conducted by the academic team around the author) identified promising new OI partners. In this respect, the use of the search field matrix allowed the definition and delegation of clear and distinctive search tasks. The **step-wise assessment** of stakeholders and potential OI partners proved to significantly reduce the respective effort. Basic OI partner criteria evaluated the fundamental suitability of OI partners and aimed at easily assessable information. Only if they fulfilled all basic criteria, OI partners were assessed in more detail concerning performance criteria. The Strategic-Operative Portfolio provided a profound overview of relevant OI partners, both from an operative and a strategic perspective. The inherent documentation proved to be an advantage (see section below): along with extreme scenarios like changing project managers, in general, it also allows a retrospective recapitulation of the OI project to vindicate decisions towards superiors as well as to enable learnings for future OI projects.

Despite the overall positive results, the evaluation also revealed a couple of **challenges and limitations**. The central challenge was the change of the OI team manager after the selection of the OI partners. Due to an insufficient hand-over of the project to his successor, there occurred misunderstandings concerning the purpose, process and state of the OI project, and the decisions made so far. In this respect, the inherent documentation of the SOI methodology evinced to be a benefit as it provided information of all previous aspects. Nevertheless, aspects of NIH and a lack of identification with the OI project could be observed. This stresses the need of a designated sponsor or promotor of the OI project that does not change for its duration. Another challenge was a **general impatience** of the company in respect to the method application and its results. To address this issue, the **modular setup of the methodology** was enhanced to enable a better adaptation and scaling of steps, for instance, the initial assessment of stakeholders to evaluate the specific need of searching for new OI partners. However, in this respect, the new OI team manager criticised a “***lack of novelty and innovativeness***” of the OI partners, that had been assessed and selected by his predecessor. Although this seems to be a matter of the change of the project manager and his differing expectations, along with the involvement of customers also seems reasonable for this OI project, it is necessary to further analyse if this is a general issue and needs to be addressed by alternative search and assessment approaches.

From a methodical point of view, the combination of a product-related and service-related innovation process in the stakeholder map evinced to be difficult. Despite their similarity, both processes are usually not completely identical. This complicated the stakeholder analysis and the derivation of the search field matrix. In general, the assessment remains a central challenge of selecting OI partners concerning **effort and access to reliable information**. In this respect, additional alternative company-specific sources of knowledge need to be identified, such as supplier databases or existing results of previous stakeholder analyses. In addition, alternative fields of use of the results from the OI planning process can be developed to increase the benefit of the SOI methodology.

8.5 Assessment of requirements of methodical support

The three presented case studies (CS) had different goals and contexts, to evaluated all aspects of the developed methodology of *Situational Open Innovation (SOI)*. While the first OI project addresses a **broad search of a multitude of new unknown OI partners** in a strategically sensitive market environment, the second OI project focusses on **solving a highly specific technical problem** by involving new OI partners. The third OI project analysed the particular challenges of **developing a new PSS**, but without constraints concerning the novelty of OI partners. The following section is based on the author’s experience and **observation of the OI projects** as well as the **direct feedback from regular project meetings and from evaluation questionnaires** that were answered by the evaluation partners (appendix 13.9).

In summary, the evaluation proves the **operative guidance** of inexperienced users of SOI as well as **flexibility** to more experienced users, i.e. the possibility to situation-specifically adapt, scale or even skip steps and activities (cf. Table 8-2). This adaptability is essential as each company needs to customise OI to its specific situation (cf. BUGANZA et al. 2011, p. 448f; ILI et al. 2010, p. 253). Based on the experience of the initial case studies, the level of **adaptability** was enhanced compared to the original version of SOI. On a method level, an adapted hybrid problem analysis model as well as separated rankings of strategically and operatively relevant

OI partners were used in case study 2. On a process level, the search step for new OI partners could be skipped in the third case study. The level of academic supervision decreased from the first to the last OI project. While the initial OI projects therefore allowed a more direct and detailed evaluation of the methodology and its comprised methods, the last OI project allowed an initial evaluation of an autonomous application of the methodology and its operative guidance. However, an **entirely autonomous application could not be analysed**. Therefore, the fulfilment level of the operative guidance was rated as medium, although the evaluation partners assessed it as higher.

Table 8-2: General requirements of OI planning methodology

	CS 1	CS 2	CS 3
Usability in industry			
Operative guidance for inexperienced users[34]	◐	◐	◐
Flexibility and adaptability for experienced users	◐	◕	●
Applicability in different project contexts			
Consideration of the boundary conditions of the company and project	●	●	●
Allow a variation of phases	●	●	●
Allow scaling of methodology	●	◕	◕
Allow adapting the methodology	◕	◕	◕
Long-term embedding in companies			
Description of the purpose and goal of elements of the methodology to increase acceptance by users	●	◕	●
Minimise effort of data-based redundancies and effort of data handling	◐	◕	◕
Description of efforts and benefits of the methodology	●	◕	●
Prevention of project failures			
Ensuring a homogenous knowledge level within the OI team	◕	●	◕
Ensuring a systematic procedure	◕	●	●
Sensitising for potential barriers and risks of OI	●	◕	●
Fostering interdisciplinary collaborations	◕	◕	●
Traceability			
Ensure traceability and transparency of process and decisions	●	◐ [35]	◐
Documentation of process and decisions	●	◐ [35]	●

[34] Although the individual company ratings are higher, these ratings consider the high amount of guidance from the academic team around the author.

[35] Due to often company-politically driven decisions and a high dependency of the specific individual, both criteria were only assessed as medium fulfilled by the industry partner.

In respect to a long-term application in companies, the existing **descriptions** of specific **benefits and effort** of steps and methods were improved based on the evaluation results. As the experience from the last OI project shows, they are sufficient but could specifically be enhanced to motivate sceptical stakeholders. By developing the OI partner search demonstrator, and integrating the OI situation analysis into the OI method selection tool, the **effort of data handling** and data redundancies could be reduced. Still, in future research, both tools can be combined and enhanced by interfaces to existing databases within the companies.

The evaluation also proves the methodology's support in preventing project failures. Its discursive elements help to explicate implicit knowledge and to ensure a **homogenous knowledge level** within the department-spanning OI team. This **interdisciplinary collaboration** of OI team members with differing backgrounds and capabilities reduces the risk of analysis biases by combining alternative perspectives and expertise. The modular but guiding structure of SOI ensures a **systematic procedure**. The ranking results of a structural analysis of OI risk dependencies supported in **sensitising for potential OI barriers and risks**. Nevertheless, so far, it just supports the discursive reflection within the OI team. In future research, dependencies between specific OI situations, OI partners and OI methods onto risks should be analysed. Due to the clear structure of the methodology's process and **documentation** of intermediate results by comprised methods, the **traceability of the process and decisions** is ensured. However, as stated by the second industry partner (cf. appendix 13.9.2), in the end, the quality and quantity of documentation and the resulting traceability of the planning process is based on the engagement of the OI team. Often it is also driven by political reasons. This can only indirectly be influenced by the methodology itself.

Table 8-3 summarises the evaluation results of the OI situation analysis. The developed approach considers influencing factors of the company-internal boundary conditions, of the market environment, of existing collaborations and the specific goal of the OI project. Based on the feedback of the industry partners (cf. Guertler et al. 2016b), the comprehensibility and measurability of criteria and specifications was enhanced but can still be improved by using alternative information sources. In addition, these criteria need to be evaluated in future OI projects concerning their generalisability and completeness.

Table 8-3: Requirements of analysing an OI situation

Analysing an OI situation	***CS 1***	***CS 2***	***CS 3***
Consideration of internal influencing factors	●	●	●
Consideration of external influencing factors	●	●	●
Consideration of existing collaboration experience	●	●	●
Ensuring the measurability of analysis criteria	◕	◕	◕

The evaluation of SOI proves the consideration of **external and internal stakeholders** concerning the OI partner search, as shown in Table 8-4. Nevertheless, the observation of the stakeholder workshops showed that the analysis of external stakeholders was more detailed than that of internal ones, which might be due to the underlying OI context of the analysis. The step-wise assessment of weighted OI partner criteria allows to reduce the corresponding **effort** while it ensures the consideration of the **operative capabilities and strategic relevance** of **known actors and newly identified OI partners**. CS 1 primarily focused on an operative perspective due to its strong focus on identifying new OI partners. In this respect, the search field matrix evinces to support the search for new OI partners by defining clear search areas and directions that can be delegated to different team members for a parallel search. The third company decided to focus on known actors. Therefore, the search for new OI partners was not central part of the third OI project and was only evaluated from an academic perspective. The software demonstrator allows the modelling of **stakeholder dependencies**, their analysis and direct use within subsequent steps of the methodology, for instance within the Strategic-Operative Portfolio. In this respect, the software can purposefully hide and show specific dependencies, such as only strong dependencies or only dependencies originating from negative stakeholders. In general, the second evaluation partner stressed the high impact of the users of SOI as the methodology itself does not generate results. For instance, SOI supports in analysing stakeholder dependencies, but these need to be identified by the users of the methodology. In respect to selecting OI partners, the evaluation partners recommended to strongly focus on a diversified group of OI partner, in order to use a wide range of expertise.

Table 8-4: Requirements of selecting OI partners

Selection of OI partners	**CS 1**	**CS 2**	**CS 3**
Consideration of external stakeholders	◕	●	●
Consideration of internal stakeholders	◕	●	●
Supporting the identification of OI partners from a known pool of actors	●	●	●
Supporting the identification of unknown new potential OI partners	◕	●	◕
Consideration of an operative technical perspective	●	◕	●
Consideration of a strategic perspective	◔	◕	●
Consideration of stakeholder dependencies and networks	●	◑ [36]	◕

By its questionnaire design, the OI method selection tool allows an **intuitive use,** but requires a basic understanding of the planning methodology. Concerning the **support of selecting suitable OI methods**, the evaluation partners particularly approved of the suitability **ranking,** which gives an overview the **situation- and partner-specific suitability of OI methods.** In this respect, it was considered a major benefit that SOI does not filter but displays all OI methods and leaves the final decision to the OI team. From their point of view, this is important for the acceptance of the tool by employees as these want to keep control of the

[36] Due to the dependency of the expertise of the method users.

planning process. The tool also allows a transparent view on the underlying ranking process. It is only limited by the inherent complexity of the central DMMs. By the use of vector representations of user inputs and OI method profiles in combination with matrix multiplication, **further OI methods can be added** in the future. Nevertheless, in the current version of the tool in Microsoft Excel, the usability of adding new OI methods is limited due to the need of manually adjusting the respective matrix calculation formulas. In general, the second evaluation partner stated that the selection and suitability of OI methods depend on the specific company and context. Therefore, he rated the level of selection support as medium, but stressed the according support and benefits of the tool and method profiles. Table 8-5 summarises the evaluation results.

Table 8-5: Requirements of selecting OI methods

Selection of OI methods	**CS 1**	**CS 2**	**CS 3**
Supporting the selection decision	●	◑[37]	●
Ranking OI methods regarding their situation and partner suitability	●	◕	●
Ensuring transparency of the ranking process	●	◕	◕
Showing advantages and disadvantages of each OI method	●	●	◕
Allowing a future enhancement by further OI methods	◕	◕	◕
Ensuring an intuitive use of the selection approach	●	◕	◑
Allowing a criteria- and software-based selection process	●	●	●

In summary, the evaluation proves the applicability and benefit of SOI in industry. Although not all requirements are completely fulfilled in each case, which indicates potential aspects for further improvements, the overall requirement fulfilment was successfully proven. SOI supports SMEs in successfully planning OI projects and enables them for boundary-spanning cooperations. All evaluation partners gave the feedback that SOI **increased their understanding of OI**, and that the **benefits of SOI were worth the effort** of applying the methodology. They also stated they **will apply SOI again** for future OI projects – and two companies have already started doing so (cf. appendix 13.9).

Asked for their approach of **planning the specific OI projects without SOI**, the responses of the evaluation partners ranged from focussing on traditional partners and neglecting new ones (CS 1), via using brainstorming and own experience, which would have been likely to miss the most valuable contents, inputs and stakeholders (CS 3), to having no alternative plan, which had meant to commission an intermediary (CS 2).

Along with learning effects for future OI projects, **alternative benefits and fields of application of SOI** were seen in internal innovation management in general, such as using the results of the situation analysis for other projects, and using OI methods for internal idea

[37] The industry partner stressed the importance of discursively discussing the prioritised OI methods in the OI team by using the OI method profiles and the highlighted trigger and exclusion criteria.

generation. The systematic process of SOI makes it applicable for a variety of different problem areas, ranging from R&D projects to non-technical issues like the development of new business models in a multi-stakeholder environment.

The **systematic procedure** was stated as **general benefit of SOI** along with its consistency and completeness of planning aspects. In particular, the methodical involvement and prioritisation of external actors was appreciated. Nevertheless, the evaluation partners also stated general aspects of improvement like additional detailed guidelines of defining and sufficiently **phrasing an actual task** of the OI project and method. In addition, a stronger focus on diversified groups of OI partners was stressed as their combination and variety of expertise directly affect the problem solving process. Another issue was the high dependency of results from the **capabilities and expertise of the method users**, which can only partly be covered by a methodology. Nevertheless, a more detailed consideration of the user perspective could be beneficial. In line with the software demonstrators, a software-based **and interactive guideline version of the methodology** was suggested, comparable to tax return software. Specific application examples and success stories could further improve the understanding and usability of the methodology. They could also be enhanced by statements of effort estimates, which will be available after several applications of SOI.

8.6 Identification success factors and barriers of methodology application industry

The case study based evaluation also revealed general success factors and barriers of methodology application in industry and of transferring knowledge from academia to industry in general. The following chapter enhances intermediate results which were presented in GUERTLER et al. (2016b) and GUERTLER AND LINDEMANN (2016a).

8.6.1 Control questions and success factors for developing a situation analysis

The following questions were derived from the evaluation of the OI situation analysis and support other researchers in developing their own situation analysis or criteria-based analysis approaches in general. They are also presented in GUERTLER et al. (2016b).

- **Is the assessment effort manageable?**

  Optimally, there are no more than 30 criteria, and/or an analysis duration of one-day maximum. Too many criteria can demotivate the industry team and lead to a boycott of the situation analysis.

- **Who is able to assess the criteria?**

  The industry partners stated that it can be demotivating to receive a large number of criteria, which they are not able to assess themselves, but need to identify colleagues who can. Therefore, it is helpful to state a potential department of the company that is likely to be able to provide the relevant information. In this case, the OI team can directly forward the criteria to suitable departments and stakeholders.

- **Do you provide an overview of the analysis process?**

  It is important to give an overview of the entire situation analysis process in the beginning as well as continuous updates about the current position in the process and the remaining steps. This lets the industry partners schedule the analysis sufficiently and maintain an overview of the progress.

- **Do you provide a description of each criterion?**

  Often the criteria names are not comprehensible in themselves and require a short description, which is in line with ENKEL et al. (2011, p. 1169f). It is also recommended to provide a short indication of why and where the criteria will be relevant in the subsequent steps of the methodology.

- **Do you prevent ambiguity?**

  Especially when working with interdisciplinary teams, terms and expressions can have varying meanings or interpretations, for instance, *innovation cycles in industry* could be interpreted as times between two technologies as well as the time period for developing a new product.

- **Are you aware of the dynamics of criteria properties?**

  In general, the situation criteria assess only one situation state of one particular project. For a subsequent project or even during the progression of a particular project, some criteria might change. To reduce the risk of misplanning, you should identify the most dynamic criteria as well as define a schedule of checking for changes of the properties.

- **Do you use time-independent criteria?**

  Dynamic changes of criteria properties pose a challenge in the situation analysis. Therefore, it is important to define the criteria themselves in a time-independent manner in order to minimize obsolescence, e.g. instead of assessing the age of a company, it is better to assess the year of founding.

- **Do you use defined specification scales for each criterion?**

  To reduce effort and the risk of obtaining unusable data and demotivating the industry partners, distinctive specification scales should be used, which is in line with ENKEL et al. (2011, p. 1169f) and HENTTONEN AND RITALA (2013, p. 8). Often specification ranges are sufficient, but without corresponding scales. Companies might try to assess the criteria as precisely as possible and spend too much unnecessary time and effort.

- **Do you provide references for Likert scales?**

  Often scale specifications, such as *low*, *medium* and *high*, are not absolutely defined. For example, the majority of companies might assess the *need for concealment* as *high*, but in one case that could mean publishing product concepts are critical, and in another, it could even include mentioning the name of the company. Consequently, providing a reference example for each scale element is beneficial, which is also in with ENKEL et al. (2011, p. 1169f).

- **Do you clarify the organizational and temporal focus level?**

  Some criteria can be assessed on different levels and for different time periods. To avoid ambiguity, it is important to specify the focus level, such as OI experience on the level of the company, the business unit, the department or the OI team. In addition, you should define if you are assessing the present, the last 10 years, or other time periods.

- **Do you consider the specific subjectivity of criteria?**

  Some criteria have a high level of subjectivity like the *attitude of employees towards external partners*. In those cases, an assessment by additional actors or substitution by other, more objective criteria might be beneficial.

- **Are you aware of inherent risks in the context of individual-related data?**

  Along with subjectivity and dynamics, individual-related data is critical. It is important to check if it is legal to even assess that data, how to ensure confidentiality and how to prevent offending persons when seeing the assessments (for instance, the *innovativeness* of individuals and groups).

- **Are you aware of potential strategic risks of the criteria?**

  Companies might refuse to assess criteria due to their high strategic relevance and resultant risks if information, such as profits or expenses for R&D, gets into wrong hands. To avoid un-assessed criteria, you should check why you need those criteria. It might be possible to obtain the underlying information with other, less critical criteria.

8.6.2 Success factors and barriers of methodology application in industry

Based on the experience of the evaluation case studies (cf. GUERTLER AND LINDEMANN 2016a) and additional research projects in industry, the following success factors and barriers of methodical support in industry were derived.

The evaluation proves the relevance of **interdisciplinary OI teams** for applying the SOI methodology from the initial situation and problem analysis, identification of relevant OI partners and selection of OI methods. In line with KARLSEN (2002) and LORENZ (2008), the differing backgrounds, knowledge bases and perspectives reduce the risk of analysis and assessment biases. In this respect **open discussions** within the OI team are essential to explicate implicit knowledge and ensure a **homogenous knowledge level** in the OI team. In this respect, a **combination of paper- and software-based tools** proved to be successful. For instance, while the paper-based stakeholder map visualises important aspects and fosters discussions between the workshop participants, the subsequent transfer into the software demonstrator allows a better data handling and following analyses. In addition, the setup of an OI and project-specific **glossary of terms** can avoid misunderstandings between different disciplines and provide orientation for new and temporary team members.

To ensure the acceptance of the methodology by internal stakeholders, it is important to clearly **state efforts, benefits and the respective time-frames** of the entire methodology and single activities, which is in line with results from other studies, like PERKMANN et al. (2011). Academia usually tends to focus on benefits of a methodology while neglecting the corresponding effort. In contrast, companies usually focus primarily on costs and need to be convinced why it is beneficial to spend them. Hence, a positive cost-benefit ratio needs to be proven for each activity.

An additional motivation factor for internal stakeholders is the use of **success stories** of previous OI projects (GIANNOPOULOU et al. 2011, p. 516, GUERTLER et al. 2014b, p. 1027). They can demonstrate the applicability and benefits of a methodology. However, there is the risk of project failures causing the opposite effect. Therefore, it is essential to ensure the (perceived) **success of the first OI project**.

A possible way to reduce the effort of application, is the **tailorability of methodologies**. For instance, a modular structure allows to adapt and scale steps and single activities according to the company-specific needs. To increase the acceptance by internal stakeholders, possible **links between the methodology and structures of the company** should be indicated, such as processes and databases. On the input side, the use of existing data sources can reduce the effort of the analysis methodology or evaluate analysis results. On the output side, additional fields of application of the methodology's results can increase its overall benefits, for instance, within subsequent projects.

In addition, the methodology can be implemented as **software system**, which stores all project-related data, and offers different analysis steps and alternative forms of results presentations. Nevertheless, the evaluation shows that a combined use of software and paper-based approach is most beneficial. Initial analysis steps, such as situation and stakeholder analysis, are executed within a **workshop** using flipcharts and posters, which are digitalised in the following. Despite the additional effort, this allows a more intuitive use and visualisation of issues. This supports an open discussion of the OI team and explicating implicit knowledge. By the use of Post-Its, elements can be easily added or restructured.

In respect to the results, the companies stated to prefer a methodology, which **supports their decisions** but does not make them automatically. Instead of only presenting the best rated option and filtering the rest, all possible options have to be presented in a ranked order. This allows a team discussion of results and consideration of implicit or highly company-specific influence factors. Closely related, is the need for a **transparent process** as basis for the decision, along with traceable intermediate results and decisions, including a sufficient **documentation**. Apart from extreme situation like project hand-overs, this can also be important to retrospectively justify specific decision or as basis of lessons learnt for future OI projects. A remaining challenge of the methodology is the **balance between completeness** with a high level of details, and an appropriate level of **pragmatism**. This cannot completely be covered by a methodology, which can give indications at best. In this respect, OI teams need to gain own experience.

From an academic perspective, the evaluation also stresses the need for a sufficient amount of self-assertion of the academic team, in order to **break daily routines and patterns of thinking** in companies and to allow new approaches and methodologies.

8.6.3 Evaluation of success factors and barriers for cross-industry workshops

Within the evaluation case study 2 (cf. chapter 8.3), motives and reasons for and against a participation of **cross-industry workshops** were evaluated. They are widely consistent with the results of ENKEL et al. (2009a, p. 151f). In respect to the **motives** of participation the asked participants were less interested in the hosting company than stated in literature, at most in terms of getting information of its needs as an indirect customer. The other motives were consistent, such as interest in the wanted solution concept, a general interest in the problem topic, interest in learning new problem solving methods, networking and the opportunity to share knowledge and increase the own reputation. The reasons of a **rejection** of an invitation could particularly be observed in the case of the invited academic partners. Along with a lack of time and a high perceived distance between the problem topic and the own field of expertise, a missing financial compensation were the central reasons for a rejection. A central **enabling factor** of OI partners accepting the invitation but also of the performance of the workshop itself was the avoidance of involving two competing OI partners. In some of the initial phone calls, it was one of the first questions if also competitors were invited. In addition, all invited actors who did not autonomously respond to the invitation were not specifically motivated by further incentive measures. **Only intrinsic motivated actors** were involved into the workshop. This ensured a high motivation and engagement of all participants, as the observation of the workshop showed.

The industry partners also stated the relevance of having a **diversified team of OI partners** for the workshop to combine different perspectives, backgrounds and competences. This can also mean to replace some high ranked OI partners by some lower ranked ones.

These insights can be used for a profound detailed planning in SOI-5. In general, companies should enhance the methodology by their company-specific insights and experience to continuously improve their OI capabilities.

9. Conclusion and outlook

This final chapter summarises the background and motivation of the presented research, and the developed methodology for planning OI projects. It also discusses the resulting contribution to academia and implications for industry as well as the limitations of the methodology. Based on this, opportunities for further research concerning SOI and OI in general are outlined.

9.1 Summary of research results

This dissertation analyses how Open Innovation (OI) can be systematically applied to increase the innovativeness and competitiveness of **SMEs as important pilla**r of the German and European economy. OI itself is an increasingly utilised innovation management approach that allows the purposeful exchange of knowledge with external OI partners, in order to enable new innovations and reduce product development costs and time. **OI projects are of high relevance** for unexperienced SMEs in particular as they have a defined scope and are decoupled from internal processes. Based on an **empirical and literature-based analysis**, reasons of the merely reluctant use of OI in SMEs are identified along with specific success factors and barriers. Subsequently, the industry needs are consolidated to **nine research gaps**, including **specific requirements**. In general, the planning of OI projects evinced as central aspect as it defines the solution space and constraints of all subsequent innovation activities. The evaluation of general characteristics and boundary conditions of SMEs revealed the need of an operative methodical support, which comprises an adaptable step-by-step guideline. The following **research questions** were derived from the prioritised research gaps: (1) *What are context factors, which influence or constrain an OI project?* (2) *Who are relevant operative and strategic, external and internal OI partners?* (3) *Which OI collaboration methods are appropriate to involve them?* (4) *How can OI and product development be combined? Which barriers can occur?*

To solve these research gaps and answer the related research questions, the methodology ***Situational Open Innovation (SOI)*** was developed as prescriptive methodical guideline. It provides an operative support to SMEs in planning OI projects. Its modular structure allows an adaptation and scaling of phases, steps and activities according to the specific situation of the company and OI project. Nevertheless, it also highlights a standard procedure for unexperienced users. In this respect, the term *situational* stresses the basic aspect of SOI: a situation-specific planning of OI projects since these are highly dependent on the particular context and goal of a project. The particular OI situation is analysed in the **first phase** of the methodology (SOI-1) and builds the basis for the following phases. The **second phase** (SOI-2) identifies and ranks suitable OI partners that are relevant for operatively developing a solution as well as for ensuring the strategic success of the OI project. The initial stakeholder analysis allows the consideration of relevant strategic partners as well as an evaluation whether a sufficient pool of potential OI partners do already exist, or new ones need to be purposefully identified, for instance, in other industry sectors. Subsequently, the **third phase** (SOI-3) ranks different OI methods concerning their suitability for the overall OI situation and the selected OI partners. Due to the high interdependency of OI partners and OI methods, it also supports to derive fitting combinations of OI partners and OI methods. These are often better than the isolated partial solutions of OI partners and OI methods. The **fourth phase** (SOI-4) addresses aspects of the succeeding project management, such as the planning of incentive strategies, of performance controlling and of risk management. While the previous phases focus on the rough planning of an OI project (i.e. what needs to be done, due to which reasons), the **fifth phase** (SOI-5) comprises the detailed project planning (i.e. how will the rough aspects be realised). This dissertation particularly focusses on the first three phases of SOI. Nevertheless, in terms of a holistic framework, the other planning activities are also considered but need to be addressed on more detail in future research.

To ensure its usability and support of SMEs, the **SOI methodology was successfully evaluated** by **three in-depth case studies with industry partners** from the field of machinery and plant engineering. The different contexts and goals allowed the evaluation of the methodology's basic applicability, resulting benefits and limitations as well as to derive initial indications concerning a generalised applicability of the methodology.

9.2 Contribution to academia and industry

This research contributes to **bridging the barrier of knowledge transfer from academia to industry**, as illustrated in Figure 1-2 (chapter 1.2.1). Traditional innovation management research tends to consider industry merely as source of knowledge (*academia-pull*) but not as receiver (*academia-push*). It focusses on descriptive studies and publications of processes and effects in industry but does not sufficiently operationalise its findings in a way that companies can use it for improving themselves. In the context of **engineering research**, this dissertation aims at bridging this barrier concerning the previously stated aspects of OI. It adapts and combines elements of existing research results with new developed methods and tools to an integrated methodology. The subsequent case-study-based evaluation in industry allows the derivation of direct implications for industry as well as contribution to academia by a focussed analysis of the methodology's effects in practice.

Contribution to academia

The dissertation provides a systematic analysis of specific barriers and reasons, which hinder SMEs from applying OI, along with corresponding needs of companies. These are consolidated to nine main research gaps[38] (chapter 3.3), which indicate fields of necessary and promising research activities for other researchers. For three prioritised research gaps (OI situation analysis, selection of OI partners and OI methods), this dissertation develops a **holistic prescriptive methodology** as methodical guideline for planning OI projects. In this respect, it shows how approaches from different research areas, such as Open Innovation, user innovation, product development, systems engineering, stakeholder analysis and project management can

[38] (1) Analysing boundary conditions and constraints, (2) Identifying and selecting suitable partners, (3) Selecting suitable OI methods, (4) Preventing uncontrolled knowledge drain, (5) Guideline how to handle (external) intellectual property rights, (6) Selecting appropriate incentive strategies for internals & externals, (7) Embedding OI within the company, (8) Assessing and controlling the performance of OI, and (9) Deciding, if OI is suitable for a specific issue

be combined. The underlying engineering perspective onto OI supports in **embedding OI within traditional product development approaches**. In general, the dissertation combines in particular the results and advantages of descriptive innovation management research with prescriptive engineering research. Therefore, **engineering research benefits** by the systematic exploitation and operationalisation of research results from innovation management. Other researchers can use these insights as well as the new methodical guideline and its single elements to plan external cooperation or to develop their own methodologies. In return, **innovation management research benefits** by in-depths insights and a more detailed understanding of processes, structures and culture in SMEs. Along with the specific assessment of SOI, the in-depth evaluation case studies reveal general **success factors of method application in industry** (chapter 8.6). The underlying **action-research** approach also allows the identification of new hitherto unconsidered aspects. This supports a better understanding of processes and working principles in companies. Therefore, the dissertation contributes to the rising research field of OI in SMEs.

In addition, these insights can be used by other researchers when developing their own methodical support or when dealing with companies in general. This contributes to a **systematic knowledge transfer between academia and industry**. Researchers can build on the insights how academic results need to be processed, in order to be applicable in companies.

Implications for industry

SOI offers an **explicit and operative support** in planning OI projects. **Without SOI**, the evaluation partners stated that they would have missed relevant planning aspects or would have commissioned an external service provider – if they had conducted an OI project at all (cf. appendix 13.9). They also stated that they **will apply SOI again for future OI projects** – with two industry partners are already using elements of SOI for internal innovation projects. The step-wise process particularly supports companies without specific experience in OI. Nevertheless, its modular structure also allows to adapt and scale SOI according to the specific boundary conditions and needs of the SMEs. In addition to the standard process through SOI, companies can purposefully start in other phases, for instance, when an existing ideation platform should be used. Although the companies, involved in the evaluation, reported high effort during the first application of SOI, they also stated that this effort decreases for future applications due to learning effects and due to already identified internal key stakeholders. They also stressed the systematic character of SOI, which **reduces the risk of planning mistakes** like neglecting relevant OI partners. It avoids spontaneous choices by companies, which often tend to focus on the "*usual suspects*" as OI partners, such as suppliers and customers. In this respect, SOI allows a systematic identification and a profound selection of suitable OI partners. It also supports in analysing and reflecting the goals of the OI project, in order to specify the actual innovation problem, the necessary operative-technical capabilities and expertise of potential OI partners. In parallel, considering a strategic perspective reduces the risk of neglecting stakeholders that are relevant for the success of the OI project, such as decision makers and future buyers of a product.

Despite the prescriptive character of SOI, the responsible OI team of the company still has full control of the planning process and decisions, but receives profound decisions support. In this respect, SOI combines the advantages of software and paper-based support. While the software demonstrator reduces the effort of data handling and documentation, preceding workshop elements using, for instance, a flip-chart-based stakeholder map, visualise issues and foster discussions within the department-spanning OI team. By this, implicit knowledge of OI team members can be explicated, which ensures a homogenous knowledge level within the OI team. These discursive elements along with department-spanning OI teams allow to manage the high dependency of OI from the specific company and project context. The resulting rankings of the OI partner and OI method selection phases allow the definition of **alternative OI partners as well as OI partner-method combinations**. These alternatives can serve as **backup** if the originally favoured ones evince to be inappropriate in later project activities, such as the detailed planning or the OI project's execution as worst case. In these situations, the OI team can switch to the backup options without the need of new extensive analysis activities. The **inherent documentation** allows a retrospective comprehension and tracing of the entire planning process and decision points. This is particularly relevant when boundary conditions change over time, or as justification of decisions, or in the case of new or changed OI team members.

9.3 Limitations and future research of Situational Open Innovation

Although the presented research is an important step towards a holistic planning and application of OI projects, several relevant aspects could only roughly be addressed. They are included in SOI to ensure this holistic perspective but need to be considered in more detail in future research. For instance, the measurement and **controlling of the OI project's performance** is essential to ensure the project's success as well as to profoundly prove its benefits towards internal stakeholders and ensure their support. This is closely linked to the field of **motivating internal and external OI partners** by appropriate incentives and acquisition strategies. In particular, establishing a trustful relationship between the focal company and OI partners is crucial for the success of the collaboration. In respect to **risk management** in SOI, OI teams benefit by a sensitisation for potential OI risks and an initial relevance ranking based on structural dependencies between OI risks (cf. chapter 2.3.4). Nevertheless, the situation-specifically relevant risks were identified discursively. Future research needs to analyse **dependencies between specific OI partners and OI methods, and OI risks**. Based on this, suitable risk management measures should be proposed. In terms of an efficient planning process and management of iterations, time curves should be implemented, comparable to Gantt charts (PMI 2013, p. 182f) and iPeM (ALBERS et al. 2016b; ALBERS AND BRAUN 2011).

Although SOI was evaluated by three in-depth case studies, the evaluation results are qualitative and **not automatically generalizable**. Further case studies are necessary to gain profound results and insights. For instance, the presented **OI situation criteria** were relevant for the three OI evaluation projects. However, alternative criteria might also be relevant for other OI projects. Another challenge is the **subjectivity of analysis** and assessment steps. Department-spanning OI teams can reduce this bias as they contribute knowledge from different backgrounds and perspectives. Nevertheless, additional methodical support can increase the quality of analyses and assessments. In this respect, SOI also needs to be better **linked to existing data bases within and outside the company**. On the one hand, this can reduce the effort and increase the quality of the analyses. On the other hand, it can increase the benefit of the methodology by identifying additional fields of use for the knowledge that was generated by the methodology. As a result, sufficient strategies and methods of documenting, storing and providing this knowledge needs to be considered.

A major challenge is the **access to reliable information** to analyse and assess an OI situation, stakeholders and new potential OI partners. In this respect, additional methods or external data bases are required to increase the quality of the analysis steps. For instance, a coupling with the partner search approach *Net-Sights* of PARRAGUEZ AND MAIER (2016) seems promising, which uses a multi-layer big data analysis in open databases, in order to identify a network of potential external partners.

In addition, the handling **of large numbers of stakeholders** and potential OI partners evinced to be difficult due the resulting analysis effort and number of dependencies. The utilisation of the developed OI partner search software demonstrator proved to reduce this effort but also needs be evaluated in further OI projects. The software can also be enhanced by further analysis functionalities, for instance, more elaborate stakeholder network analysis metrics. Along with this, the OI method selection tool needs further evaluation as well. As only 12 OI methods are considered to date (chapter 2.3.3), it can be enhanced by further ones, such as living labs (MEURER et al. 2016) or maker spaces (ANDERSON 2012). In respect to a successful long-term implementation of OI in SMEs, future research should also analyse suitable sequences of OI method applications, i.e. a categorisation into OI methods for beginners, advanced users and experts (cf. VAN DE VRANDE et al. 2009, p. 436). In addition, the methodology SOI is implemented as **interactive web-based guideline**[39] in the intranet of the industry association, which funded the research project *KME – Open Innovation*. This guideline allows to access the topic of OI and planning OI projects on different levels of detail. The underlying database structure ensures future enhancements of the guideline and methodology by new methods, tools and insights of the companies of the association. Therefore, it represents a **living system**, which can further evolve over time.

9.4 Outlook of Open Innovation in general

In addition to data bases, OI needs to be linked and integrated into processes and structures of the company as an established tool within a large innovation management toolbox. This goes along with the development of a profound **decision support when OI can generate benefits** in a product development process, and when traditional innovation methods are more suitable (cf. chapter 3.3). Although this topic is not new (cf. BEVIS AND COLE 2010; ILI et al. 2010, p. 249), it is still an open research gap due to the complexity of influencing factors and their interdependencies. Along with adapting OI itself, the long-term implementation of OI also requires adaptions within the company. These comprise, for instance, cultural changes, changes of processes in combination with purposeful agile elements, and changes of the products' architecture to enable the uncomplicated incorporation of external knowledge.

[39] It is similar to the web-based guideline of another research project (http://designingexperiences.org) but is adapted to the characteristics of SOI and the SME-specific needs of the industry association.

To ensure a successful long-term implementation of OI in companies, it is also necessary to analyse internal barriers and enablers for absorbing external knowledge in more detail. Along with a sufficient operationalisation and adaption of gained knowledge (ILI et al. 2010, p. 252; KAIN 2014), this also includes cultural aspects (such as error culture and mind-set of employees), organisational aspects (such as time and space for innovation activities) and procedural aspects (such as interfaces between processes and flexibility of processes) (ENKEL 2009, p. 189f; ILI et al. 2010, p. 252).

IP issues are another relevant aspect for OI projects. Along with the definition of appropriate ownership and usage rights, and compensation models, sufficient boundary conditions need to be identified that allow, for instance, patentable solutions.

In terms of an **improved cost-benefit ratio** of OI projects, the effect of different planning parameters (such as project duration and amount of monetary incentives) onto the performance of OI methods and OI projects need to be analysed. For instance, GUERTLER et al. (2016a) analyse the effect of different duration setting onto the amount and timely distribution of ideas and comments of community-based ideation contests. A better understanding of dependencies between input and output parameters prevents the risk of insufficient project outcomes due to spending not enough or too much effort.

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11. Table of abbreviations

Abbrevation	Description
CII	Cross-Industry Innovation
CS	Case Study
DMM	Domain Mapping Matrix
DSM	Design Structure Matrix
IP	Intellectual Property
iPeM	Integrated Product Engineering Model
IPI tool	Immersive Product Improvement tool
KPI	Key Performance Indicator
MDM	Multiple Domain Matrix
MMM	Munich Method Model
MNE	Multi-National Enterprise
N/A	Not Assessable / Not Applicable
NDA	Non-Disclosure Agreement
NIH	Not-Invented-Here syndrome
OEM	Original Equipment Manufacturer
OI	Open Innovation
PGE	Product Generation Engineering
PLC	Product Life Cycle
PoMM	Process oriented Method Model
R&D	Research and Development
PR	Public Relations
SH	Stakeholder
SHA	Stakeholder Analysis
SME	Small and Medium-sized Enterprise
SOI	Situational Open Innovation

12. List of figures, using free icons

The following figures comprise free icons from www.flaticon.com. The specific designers are stated for each Figure (Table 12-1).

Table 12-1: Figures using free icons

Figures	**Specific designers from www.flaticon.com**
Figure 1-3	Freepik, Icomoon
Figure 1-2	Freepik, Elegant Themes
Figure 1-5	Freepik
Figure 3-1	Freepik, SimpleIcon, OCHA
Figure 7-1	Elegant Themes, Freepik, SimpleIcon
Figure 7-2	Elegant Themes, Freepik
Figure 7-4	Freepik
Figure 7-5	Freepik (and drawings by Constantin von Saucken)
Figure 7-14	Freepik

13. Appendix

13.1 Supervised student theses

The following theses were supervised and closely guided by the author, and to some extent became content of this thesis (chronological order):

PE: KLÄDTKE 2013

Klädtke, Kevin: *Entwicklung eines erweiterten Stakeholderanalyse-Konzepts für Open Innovation (Development of an enhanced stakeholder-analysis concept for Open Innovation)*. Unpublished Bachelor Thesis, BT 88, Chair of Product Development, Technical University of Munich, 2014.

PE: FLEISCHER 2014

Fleischer, Sarah: *Risikomanagement in der Open Innovation (Risk management for Open Innovation)*. Unpublished Bachelor Thesis, BT 164, Chair of Product Development, Technical University of Munich, 2014.

PE: SCHNEIDER 2014

Schneider, Maria: *Entwicklung eines methodischen Vorgehens zur systematischen Planung eines Open Innovation Projekts (Development of a methodical approach for systematically planning an Open Innovation project)*. Unpublished Semester Thesis, SA 2820, Chair of Product Development, Technical University of Munich, 2014.

PE: ZAHRAN-AUFSEß 2015

Zahran-Freiin von und zu Aufseß, Sarah: *Systematische Auswahl von Open Innovation Methoden (Systematic selection of Open Innovation methods)*. Unpublished Bachelor Thesis, BT 177, Chair of Product Development, Technical University of Munich, 2015.

PE: GINARD 2015

Ginard Brunner, Gabriela: *Konzeptentwicklung zur Erfolgsmessung und Controlling von Open Innovation (Development of a concept for measuring and controlling the performance of Open Innovation)*. Unpublished Bachelor Thesis, BT 178, Chair of Product Development, Technical University of Munich, 2015.

PE: DURCHNER 2015

Durchner, Larissa: *Systematische Planung eines Open Innovation-Projekts – am Beispiel des Industrieprojekts mit Warema Renkhoff SE (Systematic planning of an Open Innovation project – in the industry project of Warema Renkhoff SE)*. Unpublished Bachelor Thesis, BT 190, Chair of Product Development, Technical University of Munich, 2015.

PE: TESCH 2015 (CO-SUPERVISOR)

Tesch, Teresa: *Anwendungskriterien zu Open Innovation Maßnahmen in der industriellen Praxis (Systematic selection of methods during the process of open innovation)*. Unpublished Semester Thesis, SA 2845, Chair of Product Development, Technical University of Munich, 2015.

PE: HAYMERLE 2015

Haymerle, Richard: *Methodische Planung von Open Innovation Projekten im Maschinen- und Anlagenbau (Systematic planning of Open Innovation projects for machinery and plant engineering)*. Unpublished Semester Thesis, SA 2903, Chair of Product Development, Technical University of Munich, 2015.

PE: ENDRES 2015

Endres, Florian: *Open Innovation: Softwaretool-basierte Bestimmung geeigneter Kooperationspartner und Einbindungsstrategien (Open Innovation: Softwaretool-based determination of relevant cooperation partners and appropriate collaboration strategies)*. Unpublished Semester Thesis, SA 2879, Chair of Product Development, Technical University of Munich, 2015.

PE: VERGES 2015

Vergés Suárez, Maria: *Open Innovation: Identifikation und Suche nach geeigneten Innovationspartnern (Open Innovation: Identification and search for suitable innovation partners)*. Unpublished Semester Thesis, SA 2878, Chair of Product Development, Technical University of Munich, 2015.

13.2 Additional background information of the state of the art

13.2.1 Alternative approaches of structuring Open Innovation

Figure 13-1 depicts two categorisation approaches based on the role of the companies[40]. LAZZAROTTI AND MANZINI (2009, p. 623) define **four modes of OI** based on the innovation funnel openness and partner variety: *closed innovators* source external knowledge only for a specific innovation phase via dyadic collaborations, *specialised collaborators* also source external knowledge only for a specific innovation phase but from various OI partners, *integrated collaborators* open the majority of their innovation phases but only cooperate with specific OI partners, and *open innovators* open majority of their innovation phases for various OI partners.

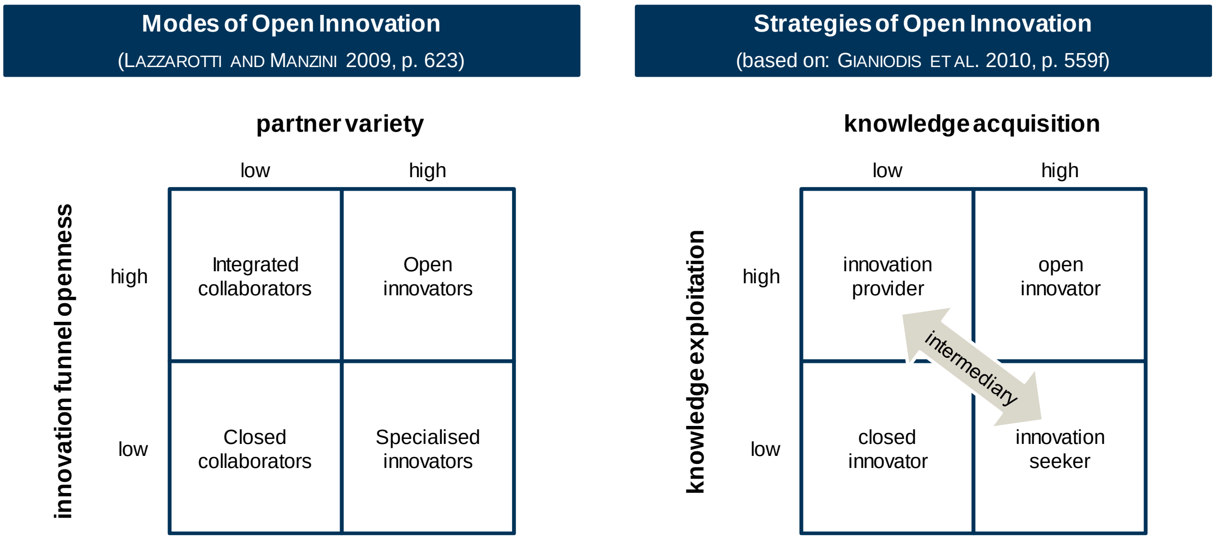


Figure 13-1: Modes and strategies of Open Innovation (GIANIODIS et al. 2010, p. 559f; LAZZAROTTI AND MANZINI 2009, p. 623)

Based on the dimensions knowledge acquisition and exploitation, GIANIODIS et al. (2010, p. 559f) define **four OI strategies**: *innovation seekers* are companies searching for external innovation solutions, *innovation providers* are companies providing innovative solutions as "products" to external partners, *open innovators* are companies acting both as innovation seeker and provider, and *intermediaries* are companies that connect innovation seekers and providers.

Linked to the previous category, HUIZINGH (2011, p. 3) based on LICHTENTHALER AND LICHTENTHALER (2009) presents a categorisation in terms of **knowledge processes**. He differentiates (1) **knowledge exploration** for generating new knowledge (DITTRICH AND DUYSTERS 2007, p. 511) that is closely linked to the monetary (2) **knowledge acquisition** (GIANIODIS et al. 2010, p. 553), (3) **knowledge retention** for combining and transferring knowledge (ZOLLO AND WINTER 2002), and (4) **knowledge exploitation** for utilising and

[40] In addition, various alternative role categorisations can be found, for instance: KEUPP AND GASSMANN (2009)

commercialising of knowledge (Dittrich and Duysters 2007, p. 511; Gianiodis et al. 2010, p. 560).

Another category is based on the economic nature of the knowledge transfer (Dahlander and Gann 2010, p. 702; Hilgers et al. 2011, p. 85). The locus of innovation (Chesbrough and Crowther 2006, p. 229) is enhanced by an **economic perspective**: pecuniary and non-pecuniary. Figure 13-2 shows the resulting categories: (1) **acquiring**: purchase of external knowledge, (2) **sourcing**: utilisation of external knowledge sources with payments, (3) **selling**: commercialisation of internal inventions and technologies, and (4) **revealing**: free distribution of internal knowledge without financial rewards.

		Locus of innovation	
		inbound OI	**outbound OI**
Knowledge exchange	**pecuniary**	acquiring	selling
	non-pecuniary	sourcing	revealing

Figure 13-2: OI categorisation – Financial perspective of knowledge exchange (Dahlander and Gann 2010, p. 702)

13.2.2 Overview of different Open Innovation partners

Table 13-1: Overview of typical OI partners

OI partners	References
Suppliers	(BOGERS AND WEST 2012, p. 65; BRUNSWICKER AND VANHAVERBEKE 2015, p. 1244; CHESBROUGH AND BOGERS 2014, p. 19; ENKEL et al. 2009b, p. 314; GASSMANN et al. 2010, p. 216; GIANNOPOULOU et al. 2011, p. 514; HENTTONEN et al. 2015, p. 8; HILGERS AND PILLER 2009, p. 5; HUIZINGH 2011, p. 5; ILI et al. 2010, p. 251; MÖSLEIN AND NEYER 2009, p. 89f; PARIDA AND JOHANSSON 2009, p. 441)
Customers	(BOGERS AND WEST 2012, p. 65; BRUNSWICKER AND VANHAVERBEKE 2015, p. 1244; CHESBROUGH AND BOGERS 2014, p. 19; ENKEL et al. 2009b, p. 314; GASSMANN et al. 2010, p. 216; HENTTONEN et al. 2015, p. 8; HILGERS AND PILLER 2009, p. 5; HUIZINGH 2011, p. 5; ILI et al. 2010, p. 251; KIRSCHNER 2012, p. 50; MÖSLEIN AND NEYER 2009, p. 89f; PARIDA AND JOHANSSON 2009, p. 441)
Users / consumers	(BOGERS AND WEST 2012, p. 65; GIANNOPOULOU et al. 2011, p. 514; HILGERS AND PILLER 2009, p. 5; KIRSCHNER 2012, p. 50)
Universities / public and private research institutes or single scientists	(BOGERS AND WEST 2012, p. 65; BRUNSWICKER AND VANHAVERBEKE 2015, p. 1244; CHESBROUGH AND BOGERS 2014, p. 19; GASSMANN et al. 2010, p. 216; GIANNOPOULOU et al. 2011, p. 514; HENTTONEN et al. 2015, p. 8; HILGERS AND PILLER 2009, p. 5; HUIZINGH 2011, p. 5; ILI et al. 2010, p. 251; LAZZAROTTI AND PELLEGRINI 2015, p. 196; MÖSLEIN AND NEYER 2009, p. 89f; PARIDA AND JOHANSSON 2009, p. 441)
Competitors	(BOGERS AND WEST 2012, p. 65; HENTTONEN et al. 2015, p. 8; HUIZINGH 2011, p. 5; ILI et al. 2010, p. 251)
Companies from other industries	(ECHTERHOFF 2014, p. 6; ENKEL et al. 2009b, p. 314; GASSMANN et al. 2010, p. 216; HUIZINGH 2011, p. 5; ILI et al. 2010, p. 251)
R&D partners	(GASSMANN et al. 2010, p. 216)
IPR experts	(BRUNSWICKER AND VANHAVERBEKE 2015, p. 1244)
Network partners	(BOGERS AND WEST 2012, p. 68; BRUNSWICKER AND VANHAVERBEKE 2015, p. 1244)
Venture capital units	(LOREN 2011, p. 12)
Standardisation organisations, Law maker	(HENTTONEN et al. 2015, p. 8; ILI et al. 2010, p. 251)
Company-internals	(MÖSLEIN AND NEYER 2009, p. 89f)
Other companies, start-ups	(CHESBROUGH AND BOGERS 2014, p. 19; GIANNOPOULOU et al. 2011, p. 514; HYLL AND PIPPEL 2016, p. 465; ILI et al. 2010, p. 251)
Consultants	(HENTTONEN et al. 2015, p. 8; ILI et al. 2010, p. 251)
Conferences, trade fairs, publications, patents	(HENTTONEN et al. 2015, p. 8)

13.2.3 Method models

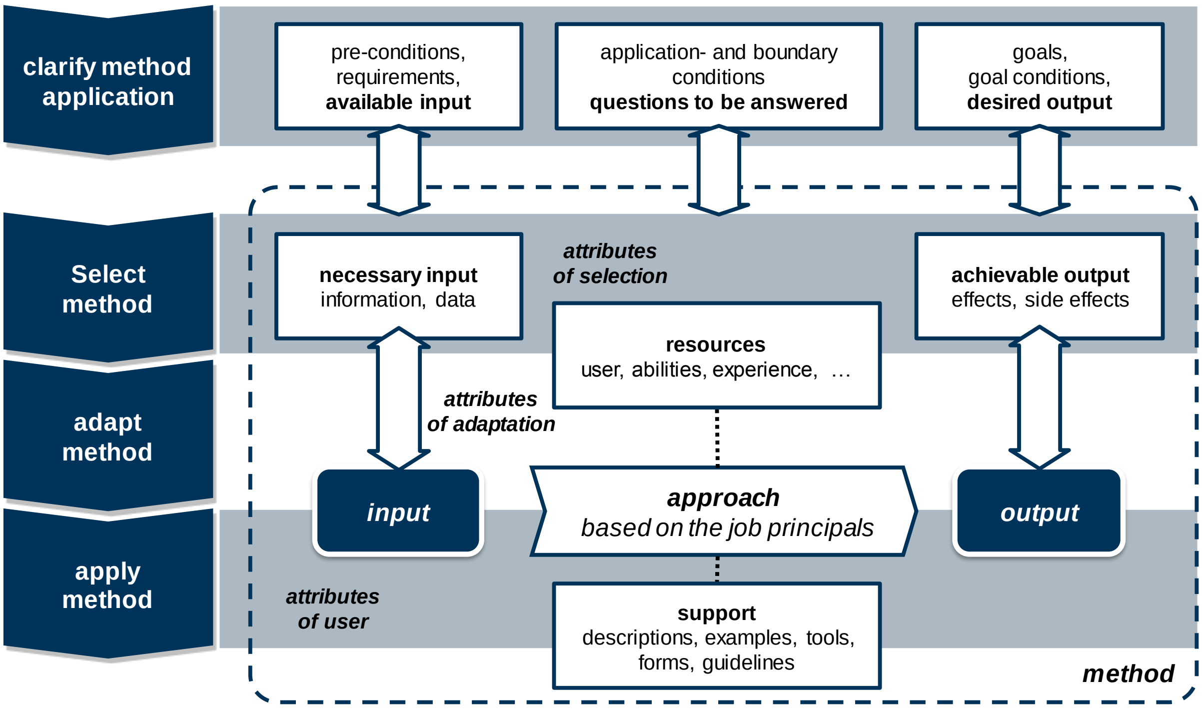


Figure 13-3: Munich Method Model (LINDEMANN 2009, p. 59f)

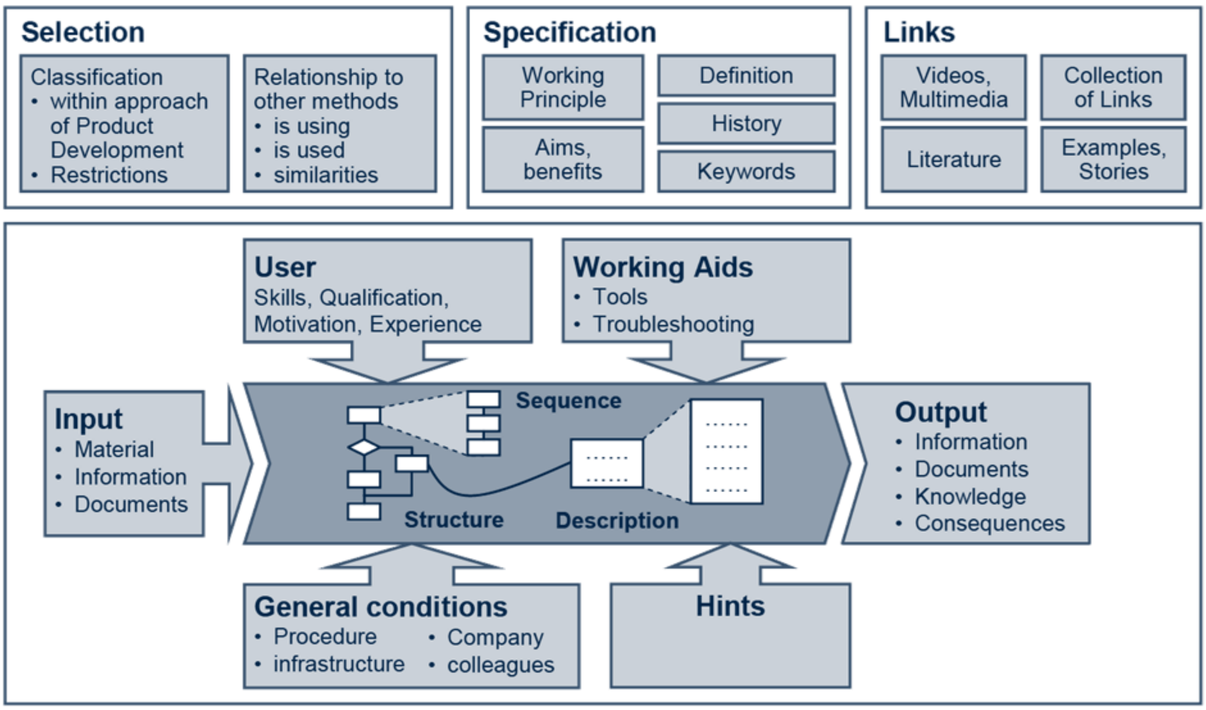


Figure 13-4: Process oriented Method Model (SAUCKEN et al. 2015, p. 206, based on: BIRKHOFER et al. 2002, p. 19)

13.2.4 Criteria of exclusion of Open Innovation methods

Table 13-2: Criteria of exclusion (ROTHE et al. 2014, p. 251)

OI methods	**Criteria of exclusion**
Lead User approach	• no Lead Users • integration of Lead Users not possible (lack of time, finances, organisational) • missing capability of moderating workshops
Idea contest	• no budget for using an external platform or for awards • missing modularisation of task • publishing of task not possible due to strategic reasons • collecting, filtering and evaluation of OI input not possible with available resources • focussed innovation addresses existing IP rights or core competences of company
OI community	• missing community • missing willingness to share (internal) knowledge • collecting, filtering and evaluation of OI input not possible with available resources • missing trust in partners
Toolkits	• implementation of task within a software or tool is not possible • no budget for external experts or expert knowledge
Internal R&D	• missing own knowledge for solving the task • no available resources for R&D • missing R&D competences or R&D department

13.3 Qualitative study for analysing industrial OI demands

13.3.1 List of participants in interview study

No.	Number of employees	Revenue [bn. €]	Industry	OI exp.	Duration of application	Fields of application
A	< 1,000	NA	Open Innovation Intermediary	yes	Long-term	Consultancy, market analysis, requirement analysis, problem solving, product ideas, information about product application, product improvements, PR
B	< 1,000	< 1	Security Technology	no*	-	-
C	< 1,000	< 1	Supplier (different industries)	yes	Long-term	Product ideas, product adaptions, product improvements, PR
D	1,000 - 10,000	1 - 5	Automotive supplier	yes	Singular	Requirement analysis, product ideas, information about product application, new fields of application, PR
E	1,000 - 10,000	1 - 5	Manufacturer of pre-products	yes	Long-term	Requirement analysis, product ideas, information about product application, new fields of application, PR
F	10,000 - 25,000	1 - 5	Manufacturer of pre-products	yes	Singular	Requirement analysis, product ideas, information about product application, new fields of application, PR
G	10,000 - 25,000	1 - 5	Technical service provider	no*	-	-
H	10,000 - 25,000	NA	Tool manufacturer	yes	Long-term	Product ideas, product adaptions, product improvements, PR
I	25,000 - 50,000	1 - 5	Light technology	yes	Long-term	Requirement analysis, product ideas, information about product application, new fields of application, contact to end-customers, new technologies, PR
J	50,000 - 100,000	15 - 30	Aeronautical engineering	yes	Long-term	Requirement analysis, product ideas, information about product application, new fields of application, contact to end-customers, cross-industry cooperation, new technologies, PR
K	50,000 - 100,000	5 - 15	Automotive supplier	yes	Long-term	NA
L	50,000 - 100,000	15 - 30	Automotive supplier	no*	-	-
M	> 100,000	> 30	Chemical industry	yes	Long-term	Requirement analysis, product ideas, information about product application, new fields of application, contact to end-customers, cross-industry cooperation, new technologies, PR

** except cooperation with universities*

13.3.2 List of participants in SME workshop

No.	Number of employees	Revenue [mil. €]	Industry	Customer type
A	1600	305 (in 2012)	Plant Manufacturer	B2B
B	1200	90 (in 2011)	Power Management Systems	B2B
C	1000	250 (in N.A.)	Automotive Supplier	B2B
D	N.A.	N.A.	Construction Industry	B2B
E	1300	150 (in 2012)	Systems Engineering	B2B
F	4200	515 (in 2011)	Assembly Technology	B2B
G	1300 (Wikipedia)	N.A.	Radio Communication	B2B
H	N.A.	N.A.	Hydraulic Systems	B2B

13.3.3 Semi-structured questionnaire of interview study

Background of interviewee and company

1. What is your position and area of responsibility within the company? Is your position already specifically linked to Open Innovation?
2. How do you define Open Innovation?
3. If Open Innovation **has not been applied** in your company:
   a. What are the reasons for not applying Open Innovation?
   b. Which preconditions need to be fulfilled to apply Open Innovation?
4. If Open Innovation **was already executed** in your company:
   a. Was Open Innovation applied as a singular activity or as part of a still ongoing Open Innovation initiative?
   b. What was the motivation for applying Open Innovation? Was it due to specific trigger events?
   c. Which other companies do you know that apply Open Innovation?

Implementation of a specific Open Innovation method

1. Which Open Innovation methods do you know?
2. Which Open Innovation methods have you or your company already applied?
3. If you have not applied Open Innovation methods so far, describe similar collaborative innovation methods that are used in your company?

4. Which specific (Open Innovation) method do you describe in the following?
5. Why was this specific method applied?
6. What was the goal of applying this method?
7. How did you / your company apply this method?
8. Which boundary conditions needed to be considered?
9. What were the selection criteria of the focussed issue, product and task settings?
10. Which barriers and challenges did occur during the method's application?
11. How did you solve those challenges?
12. Did the method's results meet your expectations? Were some results better than expected? Which results did differ from your expectations?
13. Was it possible to implement the results into daily business (into the innovation process)?
14. Which challenges did occur when transferring the results into daily business?

Résumé

1. Was it possible to meet the defined goals by applying the Open Innovation method or methods?
2. What were positive, negative or surprising experiences of applying Open Innovation?
3. Which points of potential improvements do exist from your point of view?
4. What is your general conclusion regarding the application of the described Open Innovation method?
5. Would you recommend or apply the Open Innovation method again?
6. Regarding the Open Innovation method "idea contest": would you prefer setting up an own platform or charging an intermediary that offers an all-inclusive service?
7. For which business units or product life cycle phases do you see the greatest potential for Open Innovation or involving external partners?
8. For which issues do you see the greatest potential for Open Innovation?
9. Which alternative (Open) Innovation methods bear great potential from your point of view?
10. Which Open Innovation methods are dangerous from your point of view? Due to which reasons?
11. Will you apply Open Innovation again? Did the Open Innovation project affect the company strategy?
12. Which Open Innovation method is most useful for an initial Open Innovation project?

13.4 Situation analysis spreadsheets (SOI-1)

Table 13-3: Company characteristics – part 1 (GUERTLER et al. 2016b, p. 27)

ID	Criterion	Description	Specification scale	Evaluation results	References
1.1	**Company Details**				
1.1.1	**Name of company**		<free text>		CHIARONI ET AL. 2010, 227
1.1.2	**Year of founding**	Age of company can influence its innovation culture, processes, etc.	<free number>	The use of "year of founding" prevents calculation mistakes and ensures continuous up-to-dateness as compared to "age of company".	BARGE-GIL 2010, 577, 587; BEVIS 2010, 6; CHIANG & HUNG, 2010, 294; DRECHSLER & NATTER 2012, 440; GASSMANN ET AL. 2010, 215-216; HUIZINGH 2010, 5; JIMENEZ-JIMENEZ 2010, 408; KEUPP & GASSMANN 2007; LAURSEN & SALTER 2004, 1202; LEE 2010, 290; RAMIREZ-PORTILLA ET AL. 2013, 8;
1.1.3	**Organigram of company**	Allows an overview of company's structure and interrelations between business units. Can serve as basis for a stakeholder analysis	Structure of organization and business units	New attribute, primarily based on workshop feedback.	LINDEMANN 2009, 30
1.2	**Company size**	Company's size can influence the OI capability due to available resources, etc.			ABULRUB & LEE 2012, 136, DRECHSLER & NATTER 2012, 443; GASSMANN ET AL. 2010, 215f
1.2.1	**Annual revenue**	Indicator for company performance and available resources	<five-step scale>	- European classification of companies (SME, large company, etc.) not detailed enough - Using profit as attribute is critical due to calculation and/or concealment issues	CHIARONI ET AL. 2010, 227; CHIARONI ET AL. 2011, 39; CHIANG & HUNG 2010, 294; HUIZINGH 2010, 5
1.2.2	**Number of employees**	Available human resources	<five-step scale>		CHIARONI ET AL. 2010, 227; HUIZINGH 2010, 5; LAURSEN & SALTER 2006, 141; SCHMIDT
1.3	**Size of responsible business unit**			Separate business unit analysis for a more detailed analysis.	
1.3.1	**Annual revenue**	Indicator for company performance and available resources	<five-step scale>	Introduced to differentiate between company and specific business unit	see above
1.3.2	**Number of employees**	Available human resources	<five-step scale>	see above	see above
1.4	**Strategic orientation**				PORTER 1985
1.4.1	**Company strategy**	Company strategy influences the goal and boundary conditions of an OI project as well as of the entire innovation process	Prioritization of: - Technology leadership - Quality leadership - Cost leadership	- Prioritization of options forces a clear answer - But: it can differ for different markets orproducts	PORTER 1985, 11f
1.4.2	**Revenue strategy**	Strategy influences the goal and boundary conditions of an OI project as well as of the entire innovation process	Prioritization of: - R&D - Production - Services - others	- Indicates what a company wants to achieve - Still open discussion if R&D can be a service itself	LINDEMANN 2009, 30; PORTER 1985
1.4.3	**External strategic dependencies**	Strategic dependencies to external stakeholders can influence and constrain an OI project, e.g. dependencies of suppliers or customers.	yes, no	- Indicates the degree of freedom of R&D and commercialization - Depending on business unit	GASSMANN ET AL. 2010, 214; HAGEDOORN 1993, 2002; PORTER 1985, 6
1.4.4	**Internal strategic dependencies**	Indicates if R&D activities or the OI project needs to be coordinated with other departments or business units	yes, no	Indicates potential conflict areas as well as potential sources of support	PORTER 1985, 317f

Table 13-4: Company characteristics – part 2 (GUERTLER et al. 2016b, p. 27)

ID	Criterion	Description	Specification scale	Evaluation results	References
1.5	**R&D Intensity**				R&D intensity: BARGE-GIL 2010, 577; CHIANG & HUNG 2010, 296; GASSMANN ET AL. 2010, S.215; LAURSEN & SALTER 2004, 1209; LAURSEN & SALTER 2006, 132; SCHMIDT 2005, 5
1.5.1	**ISO TS 16949 certification**	How is a company/business unit certified according to ISO TS 16949?	Developer, producer, etc.	- Allows a characterization and comparison of development process in specific industries (mainly automotive) - Relatively easy to obtain information	<Workshop>
1.5.2	**Further certifications**	Are there other industry specific certifications which allow an easy assessment of a company's innovation process?	e.g. ISO 9000/1/etc.	- ISO TS 16949 relatively specific for automotive. Thus a broader alternative might be ISO 9001 - Environmental certification	<Workshop>
1.5.3*	**Annual expenses for R&D**	Indicator for a company's innovation capability in monetary terms	<free number>	- Very sensitive data - Potentially better: ratio of R&D expenses to total expenses - Neglected for further use	expenditure R&D: CHIARONI ET AL. 2010, 227; LAURSEN & SALTER 2004, 1202; LAURSEN & SALTER 2006, 133; SOFKA 2008, 9; SOFKA & GRIMPE 2010, 310f costs R&D: DRECHSLER & NATTER 2012, 440
1.5.4	**Number of employees in R&D (in company)**	Indicator for a company's innovation capability in terms of human resources, e.g. for conducting the OI project or operationalizing the obtained OI input	<free number in 5-step accuracy>	- Differentiation in company and business unit allows more accurate determination - Potentially better: ratio of employees in R&D to employees in total	GASSMANN & KEUPP 2005, 16
1.5.5	**Number of employees in R&D (in business unit)**	Indicator for the innovation capability of the pertinent business unit in terms of human resources	<free number in 5-step accuracy>	Usually an OI project is located in a specific business unit which sets the boundary conditions for the OI project	<Workshop>
1.5.6	**R&D collaborations**	Existing (external) R&D collaborations indicate experience with collaboration in general and with specific stakeholders in particular as well as potential dependencies (stakeholders play active role)	Customer, suppliers, universities, crowd, etc.	- Utilization of drop-down menus to allow an easy answering - Here only type of stakeholders (detailed analysis within subsequent stakeholder analysis)	GASSMANN ET AL. 2010, 216
1.5.7	**Centrality of R&D**	Is R&D centralized on one site or different sites? Indicates communication and coordination effort for bigger OI projects	Central, several in one country, several in Europe, internationally distributed		GASSMANN ET AL. 2010, 213; PORTER 1985, 53
1.5.8	**Number of patents**	The number of patents indicates the effectiveness and success of a company's R&D department.	<free number>	Low relevance for the industries considered. Difficult to assess	GASSMANN ET AL. 2010, 217
1.6	**Degree of internationalization**				
1.6.1*	**Degree of globalization**	How are the company's activities spread? Indicates R&D and market potentials as well as potential dependencies	Local, national, Europe, international	Attribute is too vague, differentiation into single categories.	COHEN & LEVINTHAL 1990; GASSMANN 2006, 224; GASSMANN ET AL. 2010, 213 ; HUIZINGH 2010, 5; PORTER 1985, 54; SOFKA 2008, 9; VON ZEDTWITZ & GASSMANN 2002
1.6.2	**Number of active countries with R&D**	In how many countries does the company have R&D departments?	<5-step scale>	see above	ibid.
1.6.3	**Number of active countries with production**	In how many countries does the company have production sites?	<5-step scale>	see above	ibid.
1.6.4	**Number of active countries with sales**	In how many countries does the company have sales departments?	<5-step scale>	see above	ibid.

Table 13-5: Company characteristics – part 3 (GUERTLER et al. 2016b, p. 27)

ID	Criterion	Description	Specification scale	Evaluation results	References
1.7	**Employees**				
1.7.1*	**Innovativeness**	How does the OI team assess the general innovativeness of the company's employees?	N/A	- Definition from literature too vague - No consistent way to measure it - Each company defines innovativeness differently - lack of objectivity and comparability - "Industry itself is un-innovative but our comp. is very innovative compared to competitors."	HAUSCHILDT & SALOMO 2005
1.7.2	**Age diversity in business unit**	Indicator for creativity, since diversity should foster the creativity of teams	Age-homogenous, age-heterogeneous	- Average age is too vague - "Heterogeneous" sounds negative - maybe different term better	RASTETTER 2006
1.7.3	**Age diversity in OI project team**	Indicator for creativity, since diversity should foster the creativity of teams	Age-homogenous, age-heterogeneous	- Average age is too vague - "Heterogeneous" sounds negative - maybe different term better	RASTETTER 2006
1.7.4	**Age range in OI project team**	What is the difference between the years of birth of the oldest and the youngest team member?	<5-step scale>	- Average age is too vague - Age range is more accurate (Alternative to "age diversity")	RASTETTER 2006
1.7.5	**Gender diversity in business unit**	Indicator for creativity, since diversity should foster the creativity of teams	50:50, 25:75, 10:90, 5:95, 0:100	- "Share of women in business unit" difficult to measure - Diversity easier to assess - Gender-neutral	RASTETTER 2006
1.7.6	**Gender diversity in OI project team**	Indicator for creativity, since diversity should foster the creativity of teams	50:50, 25:75, 10:90, 5:95, 0:100	see above	RASTETTER 2006
1.8	**Company management**				
1.8.1	**Corporate management**	How is the company managed? Indicator for business strategy, management support, planning certainty, etc.	Founder, owner-family, managers, multinational, public, etc.		BEVIS 2010, 6 (form of governance); CHIANG & HUNG 2010, 297; HUIZINGH 2010, 5; LINDEMANN 2009, 30
1.8.2	**Durability of strategic decisions**	Indicator for planning and investment certainty for the OI project, more detailed than "Corporate management"	< 0.5 year, < 2 year, 2-10 years, > 10 years	- "Decision" not accurate enough. Thus, "Strategic decision" - Depends on decision's range - Maybe better: "flexible, fixed, long-term, medium-term, short-term" - Alternative: How often are decisions changed afterwards?	VERBECK 2001, 114

Table 13-6: Company's environment – part 1 (GUERTLER et al. 2016b, p. 28)

ID	Criterion	Description	Specification scale	Evaluation results	References
2.1	**Industry**				
2.1.1	**Industry of company**	Type of industry strongly influences the performance and success of an OI project	<utilization of existing characterization schemes>	Differentiation between company and business unit necessary especially in larger companies	HUIZINGH, 2010 5; JIMENEZ-JIMENEZ 2010, 408; LAURSEN & SALTER 2004, 1203; LINDEMANN 2009, 30; PILLER & WALCHER 2006, 309; SCHMIDT 2005, 9; RAMIREZ-PORTILLA ET AL. 2013, 6; Sector: BARGE-GIL 2010, 577, 581, 587; CHIARONI ET AL. 2011, 35; SCHMIDT 2005, 24
2.1.2	**Industry of business unit**	Type of industry strongly influences the performance and success of an OI project	<utilization of existing characterization schemes>	see above	<Workshop>
2.2	**Market**				
2.2.1	**Market region**	In which regions is the company active? Indicator for differing customer needs, threads, etc.	National, Europe, USA, Asia, etc.		PORTER 1985, 56
2.2.2	**Location of main / biggest market**	Where is the main market located?	National, Europe, USA, Asia, etc.	Specific naming of market to avoid misunderstandings	LAURSEN & SALTER 2006, 141
2.2.3	**Market dynamics**	How does the market develop over time? Indicator for market potential	growing, stagnating, sated, decreasing	- Easier to assess than the market size - Focus on the product which is addressed in the OI project (otherwise differentiation of different products necessary)	CHIANG & HUNG 2010, 296 (market potential)
2.2.4	**Market share**	Ratio of company's revenue to revenue of entire market Indicator for company's strength	< 5%, < 15%, < 50%, < 80%, > 80%	Correlates with production volume, which can be used as alternative	HUIZINGH 2010, 5 Market size: BEVIS 2010, 6; LAURSEN & SALTER, 2006, 132
2.2.5	**Dynamic of market share**	How will the market share of the company develop? Indicator for company's strength and market potential	growing, stagnating, sated, decreasing	- Original "market growth" mistakable (constant could mean linear growth) - Thus: just "development"	CHIANG & HUNG 2010, 296 (market potential)
2.3	**Customers**				
2.3.1	**Variety of customer groups**	How many groups of customers with differing needs do exist? Indicator for relevant groups of OI stakeholders which need to be integrated into the OI project	1, < 5, < 10, < 20, > 20	- Rephrasing of question due to ambiguity - Differentiation between physical product and services necessary	PORTER 1985, 120f
2.3.2	**Type of customer relationship**	Indicator for potential effort of acquiring OI stakeholders, collaboration boundary conditions (e.g. NDA) and incentive strategies.	B2C, B2B	Rephrasing the description due to ambiguity	BEVIS 2010, 6; GEMÜNDEN ET AL. 2007, 412; LINDEMANN 2009, 30
2.3.3	**Customer access**	Does the company have direct contact to the users or indirectly via trade intermediaries, customers of customers, etc.? Indicator for acquisition effort, knowledge about customer needs, etc.	direct, indirect	- Rephrasing of question due to ambiguity - Contacts often unsystematic ("everybody once hears something somewhere")	based on: LINDEMANN 2009, 30
2.3.4	**Customer contact**	Are there special web-platforms for selling the company's products? Indicator for interaction possibilities with customers	yes, no	Original question not feasible for tool: "How can customers buy the product? (Direct sale, web-platforms, agents, etc.)"	<own>
2.4	**External regulations**				
2.4.1	**Price regulations**	Do special price regulations exist which can limit the revenue and/or the solution space of the OI project? (e.g. customs dues, roaming fees, etc.)	none, low, medium, high, very high	Adding customs regulations	
2.4.2	**Compulsory certifications**	Do special certifications exist which can limit the solution space of the OI project? (e.g. certification of electrical components limiting crowd-based designs)	none, partial, modules, entire product		GASSMANN ET AL. 2010, 214

Table 13-7: Company's environment – part 2 (GUERTLER et al. 2016b, p. 28)

ID	Criterion	Description	Specification scale	Evaluation results	References
2.5	**Innovation cycles in industry**				
2.5.1	**Cycle duration**	What is the average time-to-market for a new idea? Indicator for time restrictions of an OI project	weeks, months, years, decades	Rephrasing question to avoid misunderstandings between development time and time between two product generations	Cycle of innovation in industry: BEVIS 2010, 7; CHIARONI ET AL. 2011, 35; ENKEL & GASSMANN ET AL. 2010, 263
2.5.2	**Cycle dependencies**	Is the cycle duration influenced by specific stakeholders? Indicator for strategic dependencies and potential OI stakeholders	Legislator, OEM, etc.		<own>
2.6.	**General influence stakeholders**				
2.6.1	**Influence groups**	Do specific groups exist that can influence the competition situation? (e.g. OEMs that want to avoid single sourcing) Indicator for potential benefit of OI project as well as potential OI stakeholders	yes, no	Important aspect especially for automotive	Suppliers' influence: PORTER 1985, 34 Buyer: PORTER 1985, 6 Legal regulations: LINDEMANN 2009, 30
2.6.2	**Strategic cooperation**	Do strategic cooperations exist within the relevant industry? (e.g. associations) Indicator for potential OI stakeholders, political instruments and/or threads	yes, no		<own>
2.6.3	**Compulsory cooperation**	Do external stakeholders exist who can cause forced cooperation with competitors? (e.g. OEMs wanting to avoid single sourcing)	yes, no	Especially in automotive industry OEMs can force suppliers to enable other suppliers in order to avoid single sourcing by the OEM	<Workshop>
2.6.4	**Number of suppliers**	How many suppliers does the company have? Indicator for strategic dependencies	single sourcing, multiple sourcing, global sourcing	Actual number of suppliers difficult to assess and not directly relevant.	PORTER 1985, 6
2.7.	**Competition intensity of company**				
2.7.1	**Number of competitors**	How many competitors exist in the main market? Indicator for level of openness and potential threads	1, < 5, < 10, < 20, > 20	- Differentiation of company and business unit necessary - Clarification: international or in specific markets	DRECHSLER & NATTER 2012, 440
2.7.2	**Competitors' strength**	How strong is the competition on the main market? Indicator for level of openness or level threads	very low, low, medium, high, very high	"Limited competition but publishing information is very dangerous"	HUIZINGH 2010, 5
2.7.3	**Type of competition**	How is the ratio of producers and customers? Alternative indicator for competition	monopoly, oligopoly, polypoly		VON HIPPEL 1988
2.7.4	**Need for concealment**	How high is the need for concealment? Indicator for level of openness or level threads	very low, low, medium, high, very high		Derived from knowledge drain: ENKEL 2009, 187f
2.7.5	**Market entry barriers**	How easily can new competitors enter the main market? Which requirements need to be met to be able to enter the market? (e.g. technologies)	very low, low, medium, high, very high	Difficult to assess Thus, replaced by 2.7.6	PORTER 1985, 5, 176
2.7.6	**Dynamics of competitors**	How often do new competitors enter the market?	never, seldom, often, regularly	Concretization of attribute "Market entry barriers"	<Workshop>, based on: PORTER 1985, 5
2.8.	**Competition intensity of business unit**		**<if needed>**		
2.8.1	**Number of competitors**	see above	see above		
2.8.2	**Competitors' strength**	see above	see above		
2.8.3	**Type of competition**	see above	see above		
2.8.4	**Need of concealment**	see above	see above		
2.8.5	**Market entry barriers**	see above	see above		
2.8.6	**Dynamics of competitors**	see above	see above		

Table 13-8: Collaboration experience – part 1 (GUERTLER et al. 2016b, p. 29)

ID	Criterion	Description	Specification scale	Evaluation results	References
3.1.	**Existing external partners**			categorization of external partners for a better specification	
3.1.1	**Number of universities**	How many universities did the company cooperate with in the last 10 years?	None, single ones, many	- Difficult to assess - Specification of timespan necessary	Number of external partners: CHIANG & HUNG 2010, 292f.; CHIARONI ET AL. 2010, 225; CHIARONI ET AL. 2011, 36; DAHLANDER & GANN 2010, 704; GASSMANN ET AL. 2010, 218; LAURSEN & SALTER 2004, 1204; LAURSEN & SALTER 2006, 135, 143; LEE 2010, 294; Type of cooperation: PILLER & WALCHER 2006, 309
3.1.2	**Number of suppliers**	How many suppliers did or does the company cooperate with in the last 10 years?	None, single ones, many	- Difficult to assess - Specification of timespan necessary	PORTER 1985, 6
3.1.3	**Number of customers**	How many customers did or does the company cooperate with in the last 10 years?	None, single ones, many	- Difficult to assess - Specification of timespan necessary	PORTER 1985, 6
3.2.	**Open Innovation experience of business unit**				
3.2.1	**Number of OI projects**	How many OI projects were or have already been conducted in the business unit? Indicator for experience / expertise with OI	None, single ones, many		GASSMANN ET AL. 2010, 216 (open innovation expertise)
3.2.2	**Applied OI methods**	Which OI collaboration methods were / are applied? Indicator for specific expertise with OI	Idea contest, co-creation, OI communities, university cooperation, cross industry, etc.		LAURSEN & SALTER 2006, 133; LINDEMANN & TRINCZEK 2011
3.2.3	**Experience with OI**	How was the experience with OI? Indicator for employees' attitude and motivation regarding external collaboration.	negative, neutral, positive	Explicit question, before implicitly in 3.2.1	<Workshop>
3.3	**General collaboration experience of business unit (as basis for OI)**			information is project-specific and sometimes difficult to generalize	
3.3.1	**Applied collaboration methods**	Which general collaboration methods were / are applied?	R&D collaborations, workshops, benchmarking, etc.		LAURSEN & SALTER 2006, 133; LINDEMANN & TRINCZEK 2011
3.3.2	**Type of external partners**	With what type of external partners has the company collaborated?	B2B / B2C / academia	- Attribute not completely clear	Nature of stakeholder: CHIARONI ET AL. 2010, 225; CHIARONI ET AL. 2011, 36; CHIANG & HUNG 2010, 295; DRECHSLER & NATTER 2012, 439, 442; GASSMANN ET AL. 2010, 218; HAGEDOORN 1993, 2002; HUIZINGH 2010, 6; JIMENEZ-JIMENEZ 2010, 412; LAURSEN & SALTER 2004, 1206; LAURSEN & SALTER 2006, 139, 140; LEE 2010, 295; RAMIREZ-PORTILLA ET AL. 2013, 3; SOFKA 2008, 8
3.3.3	**Role of external partners**	Did the external partner work autonomously or did they only fulfill to-do-lists? Indicator for potentially "unaware" OI experience	Fulfilling to-do list, autonomous development, etc.	Alternative suggestion: "Where is the development focus: in the company or at the partner's?"	<Workshop>
3.3.4	**Type of cooperation**	Which communication methods were used?	Personal meetings, workshops, webbased, etc.		DAHLANDER & GANN, 2010, 700 (type of involvement)
3.3.5	**Frequency of interaction**	How often does/did the company interact with external partners?	once, daily, weekly, monthly, annually		CHIANG & HUNG 2010, 294; HUIZINGH 2010, 6; LAURSEN & SALTER 2006, 133 (repeated collaboration)
3.3.6	**Duration of interaction**	Over which average timespan did or usually does the company interact with external partners?	Days, weeks, months, years		CHIANG & HUNG 2010, 292f; ENKEL ET AL. 2005, 432; HUIZINGH 2010, 6
3.3.7	**Typical duration of R&D projects**	How long does an average R&D project last?	< 0.5 year, < 1 year, < 2 years, < 5 years, > 5 years	Allows an alignment with "duration of interaction" and better assessment	<Workshop>

Table 13-9: Collaboration experience – part 2 (GUERTLER et al. 2016b, p. 29)

ID	Criterion	Description	Specification scale	Evaluation results	References
3.4.	**Employees mindset (business unit)**				
3.4.1	**Employees attitude towards external partners**	How is the employees' attitude towards external partners? Do they "meet on equal footing"? Indicator for need and effort of internal incentives or threads such as Not-Invented-Here syndrome	Reserved, neutral, positive, very positive	- Based on (3.2.3) - But difficult to assess - Due to company-political issues, "neutral" should be set as most negative value on the scale	degree of openness: BEVIS 2010, 6
3.4.2	**General experience with external collaboration**	How is the general experience with external collaboration? Are there projects or stakeholders which mainly influence the general picture of externals?	negative, neutral, positive	Indicator for reasons influencing the employees' attitude (3.4.1)	<Workshop>
3.5.	**Existing infrastructure**				
3.5.1	**Internal method department**	Does one or more internal departments exist, which offer methodical support for product development teams? Indicator of internal support for an OI project and of potential OI partners.	yes, no	Indicates potential support for introducing new innovation concepts in the company	<Workshop>
3.5.2	**External method consultants**	Do external consultants exist who offer methodical support for product development teams? Indicator for external support and potential OI stakeholders	yes, no	(For OI method selection tool, combined with 3.5.1 since both indicate support for planning and organizing OI)	<Workshop>
3.5.3	**IT-collaboration systems**	Are there special online platforms, company suggestion systems, supplier platforms, etc.?	yes, no	Can be used as statring point of an OI project, e.g. directly usable for an OI method or as contact point to potential OI partners	<Workshop>

Table 13-10: Topic / Open Innovation goal (GUERTLER et al. 2016b, p. 30)

ID	Criterion	Description	Specification scale	Evaluation results	References
4.1	**Goal of OI project**				
4.1.1	**Goal of superior innovation strategy**	What is the goal of a surrounding innovation strategy? --> Ensuring necessary awareness in OI team	<free text>	Embedding in superior innovation strategy strongly influences OI project	ERTL 2010, 62f <Workshop>
4.1.2	**Primary OI project goal**	What is the primary goal of the OI project? --> Ensuring necessary awareness in OI team	Identifying market/user needs, generation of ideas, solution for technical problem, others	Differentiation in primary and secondary useful to consider different "motives".	BOSCHERINI ET AL. 2010, 1073; ERTL 2010, 62f
4.1.3	**Secondary OI project goal**	What is the secondary goal of the OI project? --> Ensuring necessary awareness in OI team	<free text> e.g. testing of OI in business unit		BOSCHERINI ET AL. 2010, 1073; ERTL 2010, 62f
4.1.4	**Strategic orientation of OI project**	Prioritization of strategic goal of OI project --> Ensuring necessary awareness in OI team	Prioritization of: - Technology leadership - Quality leadership - Cost leadership	Concretization of general company's strategy	BOSCHERINI ET AL. 2010, 1073; PORTER 1985, 11f
4.1.5	**Direction of OI**	What is the general direction of the intended knowledge flow and type of OI?	outside-in, inside-out, coupled	(Our research context focuses on outside-in. Thus, here no further consideration.)	ERTL 2010, 66f; GASSMANN ET AL. 2004
4.2	**Expected innovation**				
4.2.1	**Innovation object**	What is the innovation object of the OI project?	Product, service, PSS, process, business case		BOSCHERINI ET AL. 2010, 1073; DRECHSLER & NATTER 2012, 440; GASSMANN ET AL. 2010, 217
4.2.2*	**Type of innovation**	Which type of innovation is considered for the innovation object?	Product-, service-, process-, business model innovation	Quite redundant to "innovation object"	BOSCHERINI ET AL. 2010, 1073; CHIANG & HUNG 2010, 292; HUIZINGH 2010, 5; JIMENEZ-JIMENEZ 2010, 416; LAURSEN & SALTER 2006, 136; LEE 2010, 291, 294
4.2.3	**Level of innovation**	Which level of innovation should be achieved within the OI project or by the superior development project?	Radical innovation, incremental innovation (e.g. improvement, cost reduction),		BOSCHERINI ET AL. 2010, 1073; GREEN ET AL. 1995; INAUEN & SCHENKER-WICKI 2012, 214; LINTON 2009
4.2.4	**Product-life-cycle phase**	In which product-life-cycle phase is the innovation object considered? --> Impact on e.g. number and type of suitable OI partners	R&D, conception/development, production, after sales/maintenance	Focus on the innovation object in the context of the OI project	CHIANG & HUNG 2010, 292; GRUNER 1997, 65f; HUIZINGH 2010, 5; LAURSEN & SALTER 2006, 136; VERWORN & HERRSTATT 2007, 9;
4.2.5	**Expected results of OI project**	What is the type of the expected results of the OI project? --> Ensuring necessary awareness in OI team	e.g. identification of R&D partners, identifying market needs or technical requirements, obtaining first solution ideas, obtaining solution concepts, etc.	Concretization of how far the OI project needs to be driven	<Workshop>
4.2.6	**Minimum maturity level of OI input**	Which minimum level of maturity should the OI input from OI stakeholders have? --> Selection of OI stakeholders and OI methods as well as assessment of OI input	Ideas, concepts, CAD-models, prototypes, services	Minimum requirement of maturity level supports assessment of OI input	<own>
4.3	**Modularity of innovation object**				
4.3.1	**Modularity of innovation object**	What is the level of modularity of the innovation object, e.g. in terms of number of components? The more modular a system the moresuitable for OI, due to better distribution of single tasks to external partners.	Monolithic, single components, completely modular		BALDWIN & VON HIPPEL 2011, 7
4.3.2	**Modularity of process**	What is the level of modularity of the process belonging to the innovation object, e.g. in terms of process steps?	Monolithic, single optional steps, completely modular	Separated consideration of product and process might be helpful	<Workshop>
4.4	**Specific boundary conditions of OI project**				
4.4.1	**Project deadline**	Until which date does the OI project needs to be completed? --> Time restrictions	(weeks, month, years)	Concretization by using a date instead of duration supports setting up a project plan	REYMEN 2001, 85
4.4.2	**Available man power**	What is the availability of (additional) man power?	very limited, limited but negotiable, freely available		LINDEMANN 2009, 30
4.4.3	**Available budget**	What financial budget can be allocated to the OI project?	very limited, limited but negotiable, freely available		CHIARONI ET AL. 2011, 35; LINDEMANN 2009, 30; REYMEN 2001, 85
4.4.4	**Other resources**	Are additional resources available for the OI project? (e.g. 3D-printers, ect.)	yes, no		LINDEMANN 2009, 30
4.4.5	**OI project-specific need for concealment**	What is the specific need for concealment of the OI project?	very low, low, medium, high, very high	OI project's level of concealment may differ from general level	<own>
4.5	**Organizational context**				
4.5.1	**Members of OI team**	Which company departments are directly involved in the OI team? Which one has the lead? --> Strategic support, acquisition of OI partners, etc.	R&D, innovation management, management, marketing, sales, production, etc.		ENKEL ET. AL 2005, 429 (project team)
4.5.2	**Strategic location of OI project in company**	Where is the OI project strategically located? --> Indicator for strategic support	Department, business unit, innovation management, strategic management	Concretization of attribute	Need of a gate-keeper: KEINZ ET AL. 2012, 30; SCHMIDT 2005, 6
4.5.3*	**OI project-specific collaboration**	Are there already existing cooperation with respect to the specific topic of the OI project?	<free text>	Overlap with subsequent stakeholder analysis	GASSMANN ET AL. 2010, 216 (open innovation expertise)

13.5 OI partner search method profiles (SOI-2)

The layout of the profiles (like the OI method profiles) are based on a design by Constantin von Saucken.

Broadcast search

Goal

An invitation of solving a specific “dummy” task is published to public or a target group, e.g. a community. Actors autonomously submit solution ideas. This self-selection mechanism ensures a high intrinsic motivation. Based on the quality of ideas, OI partners for solving the actual problem are identified.

Process

The OI team defines the target group, task and time for responses. Usually the task is only loosely linked to the actual problem. The invitation can be published on a web-site, print media, platforms or via email. Potential OI partners submit their ideas, which are used to evaluate their capabilities. Suitable OI partners are invited to participate in solving the actual problem.

Advantages

- ► Access to a large pool of potential OI partners, also from other industry sectors
- ► Self-selection mechanism of potential OI partners ensures a high level of intrinsic motivation

Disadvantages

- ► Dummy tasks can still provide indications of strategy and problems of the company (intermediaries might support in defining a neutral task)
- ► High effort due to running two projects (OI partner search and actual OI project)

Requirements

Infrastructure ► Is specific infrastructure required?
none | community | web-platform

Start set of actors ► Are already known actors needed?
none | a few | large group

Search direction ► How precise does it need to be?
rough topic | precise terms | **specific task**

Communication ► Type of communication channel?
virtual | face-to-face

Interaction ► What level of interaction is required?
none | **informing** | cooperation

Task settings

Type of method ► How does the method work?
open search | search in pool | assessment

Selection ► Who does the potential OI partners select?
OI team | external actors | **self selection**

Degree of familiarity ► of OI partners before search
well known | vaguely known | **completely new**

Type of results ► High quality or quantity of solutions?
quality | **quantity**

Additional results ► in addition to suitable OI partners?
topic insights | user needs | **solutions**

Effort of method

Learning ► effort for learning the OI method
low | high

Preparing ► effort for preparing the search method
low | **high**

Reusing ► effort for using the method in another project
low | high | not possible

Execution ► effort for gaining the OI input
low | high

Evaluation ► effort to assess & derive suitable partners
low | **high**

Literature ► Diener, K. and Piller, F. T. (2009): ‘The market for Open Innovation increasing the efficiency and effectiveness of the innovation process’, Aachen RWTH Aachen University.

Broadcast search

Goal

An invitation of solving a specific “dummy” task is published to public or a target group, e.g. a community. Actors autonomously submit solution ideas. This self-selection mechanism ensures a high intrinsic motivation. Based on the quality of ideas, OI partners for solving the actual problem are identified.

Process

The OI team defines the target group, task and time for responses. Usually the task is only loosely linked to the actual problem. The invitation can be published on a web-site, print media, platforms or via email. Potential OI partners submit their ideas, which are used to evaluate their capabilities. Suitable OI partners are invited to participate in solving the actual problem.

Advantages

► Access to a large pool of potential OI partners, also from other industry sectors
► Self-selection mechanism of potential OI partners ensures a high level of intrinsic motivation

Requirements

Infrastructure ► Is specific infrastructure required?
none | community | web-platform

Start set of actors ► Are already known actors needed?
none | a few | large group

Search direction ► How precise does it need to be?
rough topic | precise terms | **specific task**

Communication ► Type of communication channel?
virtual | face-to-face

Interaction ► What level of interaction is required?
none | **informing** | cooperation

Disadvantages

► Dummy tasks can still provide indications of strategy and problems of the company (intermediaries might support in defining a neutral task)
► High effort due to running two projects (OI partner search and actual OI project)

Task settings

Type of method ► How does the method work?
open search | search in pool | assessment

Selection ► Who does the potential OI partners select?
OI team | external actors | **self selection**

Degree of familiarity ► of OI partners before search
well known | vaguely known | **completely new**

Type of results ► High quality or quantity of solutions?
quality | **quantity**

Additional results ► in addition to suitable OI partners?
topic insights | user needs | **solutions**

Effort of method

Learning ► effort for learning the OI method
low | high

Preparing ► effort for preparing the search method
low | **high**

Reusing ► effort for using the method in another project
low | high | not possible

Execution ► effort for gaining the OI input
low | high

Evaluation ► effort to assess & derive suitable partners
low | **high**

Literature ► Diener, K. and Piller, F. T. (2009): ‘The market for Open Innovation increasing the efficiency and effectiveness of the innovation process’, Aachen RWTH Aachen University.

Pyramiding search

Goal

Pyramiding represents a network-based or so called *snowball search*, which uses the relationship between actors. It allows the identification of potential new OI partners in combination with a profound evaluation that utilises the experience of the forwarding actor.

Process

After defining a suitable start group, these actors are asked for other actors that are more experienced or experts in a specific topic. These are similarly asked again for further actors etc. Form the resulting pool, the OI team selects potential OI partners, discursively or by screening.

Advantages

- ► Identification of new, hitherto unknown OI partners
- ► The use of social networks allows a profound evaluation of the expertise and skills of potential OI partners

Disadvantages

- ► Search results depend on the quality of the network and an appropriate start group
- ► High effort due to personal exchange with the actors and iterations
- ► Knowledge exchange of external actors uncontrollable

Requirements

Infrastructure ► Is specific infrastructure required?
none | community | web-Platform

Start set of actors ► Are already known actors needed?
none | **a few** | large group

Search direction ► How precise does it need to be?
rough topic | precise terms | specific task

Communication ► Type of communication channel?
virtual | **face-to-face**

Interaction ► What level of interaction is required?
none | informing | **cooperation**

Task settings

Type of method ► How does the method work?
open search | search in pool | assessment

Selection ► Who does the potential OI partners select?
OI team | **external actors** | self selection

Degree of familiarity ► of OI partners before search
well known | **vaguely known** | **completely new**

Type of results ► High quality or quantity of solutions?
quality | quantity

Additional results ► in addition to suitable OI partners?
topic insights | user needs | solutions

Effort of method

Learning ► effort for learning the OI method
low | high

Preparing ► effort for preparing the search method
low | high

Reusing ► effort for using the method in another project
low | high | not possible

Execution ► effort for gaining the OI input
low | **high**

Evaluation ► effort to assess & derive suitable partners
low | **high**

Literature ► Hippel, E. von, Franke, N. and Prügl, R. (2009): 'Pyramiding: Efficient search for rare subjects', Research Policy, vol. 38, no. 9, pp. 1397–1406.

Media-based searching

Goal

Searching represents an open, media-based search, which utilises search engines, databases etc. Specifically defined search terms allow a purposeful search for OI partners with particular characteristics.
Depending on the utilised search engine, the OI team can also gain insights in specific topics.

Process

Based on the given problem, search terms are defined as precise as possible, which describe required expertise and skills of OI partners. The terms are used for searching for OI partners by search engines or in specific databases.

Advantages

- ► Open and broad search
- ► Identifying a multitude of new potential OI partners
- ► Incognito search without drawing the attention of external actors like competitors

Requirements

Infrastructure ► Is specific infrastructure required?
none | community | web-Platform

Start set of actors ► Are already known actors needed?
none | a few | large group

Search direction ► How precise does it need to be?
rough topic | **precise terms** | specific task

Communication ► Type of communication channel?
virtual | face-to-face

Interaction ► What level of interaction is required?
none | informing | cooperation

Disadvantages

- ► Search results depend on quality of search terms
- ► High assessment effort of potential OI partners due to large number and often limited reliable information about them

Task settings

Type of method ► How does the method work?
open search | search in pool | assessment

Selection ► Who does the potential OI partners select?
OI team | external actors | self selection

Degree of familiarity ► of OI partners before search
well known | vaguely known | **completely new**

Type of results ► High quality or quantity of solutions?
quality | **quantity**

Additional results ► in addition to suitable OI partners?
topic insights | user needs | solutions

Effort of method

Learning ► effort for learning the OI method
low | high

Preparing ► effort for preparing the search method
low | high

Reusing ► effort for using the method in another project
low | high | **not possible**

Execution ► effort for gaining the OI input
low | **high**

Evaluation ► effort to assess & derive suitable partners
low | **high**

Literature ► Echterhoff, N. (2014): Systematik zur Planung von Cross-Industry-Innovationen, Dissertation: Universität Paderborn, Münster, Germany: Verlagshaus Monsenstein und Vannerdat OHG, p. 120f.

13.6 Open Innovation method profiles (SOI-3)

Based on SAUCKEN et al. (2015), GUERTLER et al. (2015a) and chapter 2.3.3. The graphical design was developed by Constantin von Saucken.

Broadcasting

Goal

Broadcasting publishes a specific task to a large group of potential OI partners and invites them to contribute ideas and concepts. These are submitted to a mailbox without an interaction of OI partners. This reduces the risk of knowledge drain compared to ideation contests.

Process

The OI team defines target groups, start, duration and task. Subsequently, the target groups are invited to participate and submit their ideas to a kind of mailbox.

Advantages

- ► Access to a broad pool of experts (industry-spanning)
- ► Company-internal broadcasting supports department-spanning networks
- ► Self-selection of intrinsic motivated OI partners

OI Partner

Quantity ► How many OI partners are involved?
select. individuals | **select. multiple** | **as many as poss.**

Required knowledge ► What knowledge do they need?
no knowledge | basic knowledge | **expert knowledge**

Cooperation ► What is the type of cooperation?
pull knowledge | exchange knowl. | collaboration

Communication ► Type of communication channel?
virtual | face-to-face

Interaction ► Do different OI-partners work together?
none | possible | required

Disadvantages

- ► Task and questions can give indications of strategies or problems of the company
- ► No mutual feedback and evolution of ideas
- ► Quantity and quality of responses depend on sufficient placing of the task's invitation

Task Setting

OI Goal ► What shall be achieved by using the method?
determine needs | **create solutions** | assess solutions

OI Execution ► Who is using the OI-method?
self (OI team) | delegation

Initial product ► Is an existing product required?
not required | required

Maturity level of solutions ► How concrete is the input?
idea (1D) | **concept (2D)** | **implement. (3D)**

Openess of topic ► How open is the task setting?
free | **given direction** | **restricted**

Kind of result ► High quality or quantity of solutions?
quality | quantity

Degree of innovation ► How novel are the solutions?
incremental | **radical**

Effort of Method

Learning ► effort for learning the OI method
low | high

Preparing ► effort for preparing the method
low | **high**

Reusing ► effort for using the method in another project
low | high | not possible

Executing ► effort for gaining the OI input
low | high

Operationalising ► effort for processing the OI input
low | **high**

Operating life ► use horizon of OI method
once | permanent

Shortest time to results ► from planning until results
days | weeks | **months**

Literature ► Diener, K. and Piller, F. T. (2009): 'The market for Open Innovation increasing the efficiency and effectiveness of the innovation process', Aachen RWTH Aachen University.

Communities for OI

Goal

Communities are informal groups of users with a common interest, e.g. a specific product. Companies can utilise the experience and expertise of the users to solve problems within this field of interest. Along with the use of existing communities, companies can setup new communities.

Process

For existing communities, first the community's culture needs to be evaluated, an appropriate task be defined and incentives selected. Setting up a new community is more complex. Therefore see BLOHM (2013).

Advantages

- Community users usually have a long-term experience and motivation to solve tasks within the field of interest
- Access to a multitude of capabilities and expertise of users and their collective intelligence

Disadvantages

- High economic and temporal effort of setting up and managing a new community
- For existing communities, relevant posts need to be identified
- Results depend on culture and dynamics of the group

OI Partner

Quantity ▶ How many OI partners are involved?
select. individuals | select. multiple | **as many as poss.**

Required knowledge ▶ What knowledge do they need?
no knowledge | **basic knowledge** | **expert knowledge**

Cooperation ▶ What is the type of cooperation?
pull knowledge | **exchange knowl.** | collaboration

Communication ▶ Type of communication channel?
virtual | face-to-face

Interaction ▶ Do different OI partners work together?
none | possible | **required**

Task Setting

OI Goal ▶ What shall be achieved by using the method?
determine needs | **create solutions** | **assess solutions**

OI Execution ▶ Who is using the OI method?
self (OI team) | delegation

Initial product ▶ Is an existing product required?
not required | **required**

Maturity level of solutions ▶ How concrete is the input?
idea (1D) | **concept (2D)** | implement. (3D)

Openess of topic ▶ How open is the task setting?
free | **given direction** | restricted

Kind of result ▶ High quality or quantity of solutions?
quality | quantity

Degree of innovation ▶ How novel are the solutions?
incremental | **radical**

Effort of Method

Learning ▶ effort for learning the OI method
low | high

Preparing ▶ effort for preparing the method
low | **high**

Reusing ▶ effort for using the method in another project
low | high | not possible

Executing ▶ effort for gaining the OI input
low | **high**

Operationalising ▶ effort for processing the OI input
low | **high**

Operating life ▶ use horizon of OI method
once | **permanent**

Shortest time to results ▶ from planning until results
days | **weeks** | months

Literatur ▶ Blohm, I. (2013): Open Innovation Communities: Absorptive Capacity und kollektive Ideenbewertung, Wiesbaden: Springer Gabler. ▶ Fichter, K. (2009): 'Innovation communities: The role of networks of promotors in Open Innovation', R&D Management, vol. 39, no. 4, pp. 357–371.

Cross-Industry Innovation

Goal

Cross-Industry innovations focus on the identification and adaption of existing solutions from other industry sectors to solve a specific problem. These solutions can be technologies, knowledge concepts, methods, business processes or models.

Process

To avoid mental fixation, firstly the problem is abstracted. Then promising industry sectors and suitable OI partners and solution concepts are identified. The actual development and adaption of the solution usually takes place within a workshop.

Advantages

► High potential of radical innovations
► Reduced risk of technical failures by adapting already established solution concepts
► Strengthening the own innovativeness by accessing new knowledge, technologies and competence fields

Disadvantages

► Systematic search for suitable industry sectors is challenging
► Transfer and adaption of solutions is not trivial and requires additional effort

OI Partner

Quantity ► How many OI partners are involved?
select. individuals | select. multiple | as many as poss.

Required knowledge ► What knowledge do they need?
no knowledge | basic knowledge | **expert knowledge**

Cooperation ► What is the type of cooperation?
pull knowledge | exchange knowl. | **collaboration**

Communication ► What is the type of cooperation?
virtual | **face-to-face**

Interaction ► Do different OI-partners work together?
none | **possible** | required

Task Setting

OI Goal ► What shall be achieved by using the method?
determine needs | **create solutions** | assess solutions

OI Execution ► Who is using the OI-method?
self (OI team) | delegation

Initial product ► Is an existing product required?
not required | **required**

Maturity level of solutions ► How concrete is the input?
idea (1D) | **concept (2D)** | **implement. (3D)**

Openess of topic ► How open is the task setting?
free | **given direction** | **restricted**

Kind of result ► High quality or quantity of solutions?
quality | quantity

Degree of innovation ► How novel are the solutions?
incremental | **radical**

Effort of Method

Learning ► effort for learning the OI method
low | **high**

Preparing ► effort for preparing the method
low | **high**

Reusing ► effort for using the method in another project
low | high | **not possible**

Executing ► effort for gaining the OI input
low | **high**

Operationalising ► effort for processing the OI input
low | high

Operating life ► use horizon of OI method
once | permanent

Shortest time to results ► from planning until results
days | weeks | **months**

Literature ► Echterhoff, N. (2014): Systematik zur Planung von Cross-Industry-Innovationen, Dissertation: Universität Paderborn, Münster, Germany: Verlagshaus Monsenstein und Vannerdat OHG. ► Brunswicker, S. and Hutschek, U. (2010): 'Crossing horizons: Leveraging cross-industry innovation search in the front-end of the innovation process', International Journal of Innovation Management, vol. 14, no. 04, pp. 683–702.

University cooperation

Goal

Cooperations with universities and research institutes focus on actively involving researchers and students into the own innovation process to get access to recent research results and a quantity of creative ideas. In addition, own equipment and systems can be provided to gain feedback concerning their usability.

Process

A university cooperation can be realised via dyadic cooperations, framework contracts, or via publicly funded joint research projects. In this respect, fitting universities and research institutes need to be identified. Due to highly specific requirements of public funding announcements, the experience of universities should be used.

Advantages

- ► Access to recent research results
- ► Access to a large pool of young and innovative talents and potential recruits
- ► Contact to other companies involved in funded joint research projects

Disadvantages

- ► Negotiating and setting up cooperation agreements often time-consuming (IP rights, scientific publications)
- ► Developed solutions and technologies often not ready for industrial application; thus, companies need to develop them further internally

OI Partner

Quantity ► How many OI partners are involved?
select. individuals | select. multiple | as many as poss.

Required knowledge ► What knowledge do they need?
no knowledge | basic knowledge | expert knowledge

Cooperation ► What is the type of cooperation?
pull knowledge | exchange knowl. | collaboration

Communication ► What is the type of cooperation?
virtual | face-to-face

Interaction ► Do different OI partners work together?
none | possible | required

Task Setting

OI Goal ► What shall be achieved by using the method?
determine needs | create solutions | assess solutions

OI Execution ► Who is using the OI method?
self (OI team) | delegation

Initial product ► Is an existing product required?
not required | required

Maturity level of solutions ► How concrete is the input?
idea (1D) | concept (2D) | implement. (3D)

Openess of topic ► How open is the task setting?
free | given direction | restricted

Kind of result ► High quality or quantity of solutions?
quality | quantity

Degree of innovation ► How novel are the solutions?
incremental | radical

Effort of Method

Learning ► effort for learning the OI method
low | high

Preparing ► effort for preparing the method
low | high

Reusing ► effort for using the method in another project
low | high | not possible

Executing ► effort for gaining the OI input
low | high

Operationalising ► effort for processing the OI input
low | high

Operating life ► use horizon of OI method
once | permanent

Shortest time to results ► from planning until results
days | weeks | months

Literature ► Fabrizio, K. (2006): 'The use of university research in firm innovation', In: Chesbrough, H. W., Vanhaverbeke, W. and West, J. (eds) Open Innovation: Researching a new paradigm, New York, USA: Oxford University Press, pp. 134–160. ► Philbin, S. (2008): 'Process model for university-industry research collaboration', European Journal of Innovation Management, vol. 11, no. 4, pp. 488–521.

Ideation contest

Goal

Ideation contests publish a task to public or a specific group of OI partners. They aim for a multitude of different creative ideas that are submitted within a specific time frame. They allow an evolution of ideas by feedback and enhancements of other users.

Process

The OI team defines the target group, task and duration of the ideation contest. OI partners autonomously submit solution ideas, and can rate and enhance other ideas. The best ideas are evaluated and selected by the users and finally a jury. Thus, assessment criteria need to be published from the start.

Advantages

- ► A multitude of different creative ideas
- ► Users can have, but do not need, specific expertise in the field of the task
- ► Evolution of ideas by mutual feedback and extensions
- ► Insights into users needs by observing their discussion

OI Partner

Quantity ► How many OI partners are involved?
select. individuals | select. multiple | **as many as poss.**

Required knowledge ► What knowledge do they need?
no knowledge | **basic knowledge** | expert knowledge

Cooperation ► What is the type of cooperation?
pull knowledge | exchange knowl. | collaboration

Communication ► What is the type of cooperation?
virtual | face-to-face

Interaction ► Do different OI partners work together?
none | **possible** | required

Disadvantages

- ► High effort of evaluating and operationalising the quantity of ideas with differing quality
- ► Risk of many ideas being unusable
- ► Low task complexity to allow many ideas
- ► Tasks usually visible to public

Task Setting

OI Goal ► What shall be achieved by using the method?
determine needs | **create solutions** | **assess solutions**

OI Execution ► Who is using the OI method?
self (OI team) | delegation

Initial product ► Is an existing product required?
not required | required

Maturity level of solutions ► How concrete is the input?
idea (1D) | concept (2D) | implement. (3D)

Openess of topic ► How open is the task setting?
free | **given direction** | restricted

Kind of result ► High quality or quantity of solutions?
quality | **quantity**

Degree of innovation ► How novel are the solutions?
incremental | **radical**

Effort of Method

Learning ► effort for learning the OI method
low | high

Preparing ► effort for preparing the method
low | **high**

Reusing ► effort for using the method in another project
low | high | not possible

Executing ► effort for gaining the OI input
low | high

Operationalising ► effort for processing the OI input
low | **high**

Operating life ► use horizon of OI method
once | permanent

Shortest time to results ► from planning until results
days | weeks | **months**

Literature ► Walcher, D. (2007): Der Ideenwettbewerb als Methode der aktiven Kundenintergration: Theorie, empirische Analyse und Implikationen für den Innovationsprozess, Wiesbaden, Germany: Deutscher Universitäts-Verlag. ► Wenger, J. E. (2014): Innovationswettbewerbe und Incentives: Zielsetzung, Hebelwirkung, Gewinne, Wiesbaden, Germany: Springer Gabler.

Ideation platform

Goal

Ideation platforms publish tasks to their users, who can submit solution ideas. In addition, they can rate or enhance other solutions. In contrast to single ideation contests, ideation platforms are timely unlimited and comprise a pool of frequent users. Based on the settings, also users can initiate a task solving process.

Process

The OI team places a task on a virtual platform. Existing members of the platform as well as specifically invited OI partners can submit solution ideas and concepts. Companies can either set up their own platform (high investments) or use existing platforms that are usually operated by OI intermediaries.

Advantages

- ► Continuous and timely unlimited idea generation
- ► Users can freely submit ideas
- ► Evolution of ideas by feedback and enhancements by other users
- ► Needs of platform users can be identified

OI Partner

Quantity ► How many OI partners are involved?
select. individuals | select. multiple | **as many as poss.**

Required knowledge ► What knowledge do they need?
no knowledge | **basic knowledge** | expert knowledge

Cooperation ► What is the type of cooperation?
pull knowledge | **exchange knowl.** | collaboration

Communication ► What is the type of cooperation?
virtual | face-to-face

Interaction ► Do different OI partners work together?
none | **possible** | required

Disadvantages

- ► Challenging to ensure quantity and quality of platform users
- ► High variance of quantity and quality of solution ideas
- ► Tasks and users need to be matched
- ► Tasks usually visible to public

Task Setting

OI Goal ► What shall be achieved by using the method?
determine needs | **create solutions** | **assess solutions**

OI Execution ► Who is using the OI method?
self (OI team) | delegation

Initial product ► Is an existing product required?
not required | required

Maturity level of solutions ► How concrete is the input?
idea (1D) | concept (2D) | implement. (3D)

Openess of topic ► How open is the task setting?
free | given direction | restricted

Kind of result ► High quality or quantity of solutions?
quality | **quantity**

Degree of innovation ► How novel are the solutions?
incremental | **radical**

Effort of Method

Learning ► effort for learning the OI method
low | high

Preparing ► effort for preparing the method
low | **high**

Reusing ► effort for using the method in another project
low | high | not possible

Executing ► effort for gaining the OI input
low | high

Operationalising ► effort for processing the OI input
low | **high**

Operating life ► use horizon of OI method
once | **permanent**

Shortest time to results ► from planning until results
days | weeks | **months**

Literature ► Reichwald, R. and Piller, F. T. (2009): Interaktive Wertschöpfung, 2nd edn, Wiesbaden, Germany: Gabler, p. 197f.

Immersive Product Improvement

Goal

Immersive Product Improvement (IPI) provides a defined and controlled feedback channel for users of a product. users can specifically highlight positive and negative elements and features of the product, and rate and comment on existing comments. In addition, they can also post ideas of potential improvements.

Process

Using a physical product or a virtual model, OI partners (i.e. users) can place their positive and negative feedback directly at the particular elements of a product. Other users can rate and provide feedback to other comments. This allows the identification of improvement focusses and potential solution ideas.

Advantages

- ► Intuitive use by OI partners due to visual presentation, collection and documentation of information
- ► Automatic information structuring and pre-evaluation can be run in the background of web-based implementations of IPI

Disadvantages

- ► Suitable products need sufficient visual reference points that can be linked to product functions and properties
- ► According software not freely available to date, and needs to be implemented by the company

OI Partner

Quantity ► How many OI partners are involved?
select. individuals | **select. multiple** | as many as poss.

Required knowledge ► What knowledge do they need?
no knowledge | **basic knowledge** | **expert knowledge**

Cooperation ► What is the type of cooperation?
pull knowledge | exchange knowl. | collaboration

Communication ► What is the type of cooperation?
virtual | **face-to-face**

Interaction ► Do different OI partners work together?
none | **possible** | required

Task Setting

OI Goal ► What shall be achieved by using the method?
determine needs | **create solutions** | **assess solutions**

OI Execution ► Who is using the OI method?
self (OI team) | delegation

Initial product ► Is an existing product required?
not required | **required**

Maturity level of solutions ► How concrete is the input?
idea (1D) | concept (2D) | implement. (3D)

Openess of topic ► How open is the task setting?
free | **given direction** | restricted

Kind of result ► High quality or quantity of solutions?
quality | quantity

Degree of innovation ► How novel are the solutions?
incremental | radical

Effort of Method

Learning ► effort for learning the OI method
low | high

Preparing ► effort for preparing the method
low | **high**

Reusing ► effort for using the method in another project
low | **high** | not possible

Executing ► effort for gaining the OI input
low | high

Operationalising ► effort for processing the OI input
low | high

Operating life ► use horizon of OI method
once | **permanent**

Shortest time to results ► from planning until results
days | **weeks** | months

Literature ► Kirschner, R. J., Kain, A., Lang, A. and Lindemann, U. (2011): 'Immersive Product Improvement IPI - First empirical results of a new method', Proceedings of 18th International Conference on Engineering Design (ICED11). Copenhagen, Denmark, 15.-18.08.2011, pp. 295–304. ► Kirschner, R. J. (2012): Methodische offene Produktentwicklung, Dissertation: Technical University of Munich (TUM), Munich, Germany, p. 121f.

OI intermediary

Goal

OI intermediaries are service providers that support unexperienced companies in planning, executing and operationalising OI projects, or specific activities. Intermediaries usually have their specific fields of competences and therefore need to be selected carefully by the company.

Process

Firstly, a suitable intermediary needs to be identified and commissioned. He supports in selecting a suitable problem, OI partners and resulting task. Subsequently, the intermediary supervises the involvement of OI partners and operationalisation of gained knowledge.

Advantages

- ▶ Acceleration of OI projects
- ▶ Reduced risk of the OI projects due to the use of the expertise of the intermediary
- ▶ Intermediary acts as neutral actor
- ▶ Offered service can scaled to the company's needs

Disadvantages

- ▶ Intermediaries cause extra costs
- ▶ OI project and results directly depend on the choice of the right intermediary
- ▶ Risk of intermediaries trying to sell their "standard service" without considering the company's needs

OI Partner

Quantity ▶ How many OI partners are involved?
select. individuals | select. multiple | as many as poss.

Required knowledge ▶ What knowledge do they need?
no knowledge | basic knowledge | expert knowledge

Cooperation ▶ What is the type of cooperation?
pull knowledge | exchange knowl. | collaboration

Communication ▶ What is the type of cooperation?
virtual | face-to-face

Interaction ▶ Do different OI partners work together?
none | possible | required

Task Setting

OI Goal ▶ What shall be achieved by using the method?
determine needs | create solutions | assess solutions

OI Execution ▶ Who is using the OI method?
self (OI team) | delegation

Initial product ▶ Is an existing product required?
not required | required

Maturity level of solutions ▶ How concrete is the input?
idea (1D) | concept (2D) | implement. (3D)

Openess of topic ▶ How open is the task setting?
free | given direction | restricted

Kind of result ▶ High quality or quantity of solutions?
quality | quantity

Degree of innovation ▶ How novel are the solutions?
incremental | radical

Effort of Method

Learning ▶ effort for learning the OI method
low | high

Preparing ▶ effort for preparing the method
low | high

Reusing ▶ effort for using the method in another project
low | high | not possible

Executing ▶ effort for gaining the OI input
low | high

Operationalising ▶ effort for processing the OI input
low | high

Operating life ▶ use horizon of OI method
once | permanent

Shortest time to results ▶ from planning until results
days | weeks | months

Literature ▶ Diener, K. and Piller, F. T. (2009): 'The market for Open Innovation increasing the efficiency and effectiveness of the innovation process', Aachen RWTH Aachen University. ▶ Janssen, W., Bouwman, H., van Buuren, R. and Haaker, T. (2014): 'An organizational competence model for innovation intermediaries', European Journal of Innovation Management, vol. 17, no. 1, pp. 2–24.

Lead User approach

Goal

The Lead User approach focusses on the identification of outstanding users who are ahead of their time and have specific competences and skills. By involving them, companies can early identify relevant trends and develop according solutions and products.

Process

After defining specific Lead-User criteria, Lead Users need to be identified using different available search methods, such as screening, pyramiding and netnography. The collaboration with the evaluated and selected Lead Users usually takes place within a workshop.

Advantages

- Early identification of user needs and trends
- Lead Users can support R&D activities and evaluation
- Development of customer relevant solution concepts and products

Disadvantages

- Challenging identification of suitable Lead Users
- High effort of searching for them
- Risk of focussing on "false" Lead Users and niche markets

OI Partner

Quantity ► How many OI partners are involved?
select. individuals | select. multiple | as many as poss.

Required knowledge ► What knowledge do they need?
no knowledge | basic knowledge | expert knowledge

Cooperation ► What is the type of cooperation?
pull knowledge | exchange knowl. | collaboration

Communication ► What is the type of cooperation?
virtual | face-to-face

Interaction ► Do different OI partners work together?
none | possible | required

Task Setting

OI Goal ► What shall be achieved by using the method?
determine needs | create solutions | assess solutions

OI Execution ► Who is using the OI method?
self (OI team) | delegation

Initial product ► Is an existing product required?
not required | required

Maturity level of solutions ► How concrete is the input?
idea (1D) | concept (2D) | implement. (3D)

Openess of topic ► How open is the task setting?
free | given direction | restricted

Kind of result ► High quality or quantity of solutions?
quality | quantity

Degree of innovation ► How novel are the solutions?
incremental | radical

Effort of Method

Learning ► effort for learning the OI method
low | high

Preparing ► effort for preparing the method
low | high

Reusing ► effort for using the method in another project
low | high | not possible

Executing ► effort for gaining the OI input
low | high

Operationalising ► effort for processing the OI input
low | high

Operating life ► use horizon of OI method
once | permanent

Shortest time to results ► from planning until results
days | weeks | months

Literature ► Hippel, E. von, Franke, N. and Prügl, R. (2009): 'Pyramiding: Efficient search for rare subjects', Research Policy, vol. 38, no. 9, pp. 1397–1406. ► Reichwald, R. and Piller, F. T. (2009): Interaktive Wertschöpfung, 2nd edn, Wiesbaden, Germany: Gabler, p. 180f.

Netnography

Goal

By passively observing and analysing a community, Netnography allows to gain knowledge about user needs and potential solution ideas. In addition, particularly outstanding users can be identified as potential OI partners or even as long-term recruits.

Process

After identifying a suitable community, specific search and analysis questions are defined. They are used to analyse community posts manually or software-based. The analysis results can be discussed with selected community users.

Advantages

- ► Unrecognised observing: without drawing interest of community users and competitors
- ► Access to implicit knowledge of needs and solutions
- ► Involvement of active and outstanding users into the problem solving process

Disadvantages

- ► Identification of suitable communities with sufficient activity of users
- ► High effort and experience dependency of analysis
- ► High quantity of posts with differences in quality and language

OI Partner

Quantity ► How many OI partners are involved?
select. individuals | **select. multiple** | as many as poss.

Required knowledge ► What knowledge do they need?
no knowledge | **basic knowledge** | **expert knowledge**

Cooperation ► What is the type of cooperation?
pull knowledge | exchange knowl. | collaboration

Communication ► What is the type of cooperation?
virtual | face-to-face

Interaction ► Do different OI partners work together?
none | possible | **required**

Task Setting

OI Goal ► What shall be achieved by using the method?
determine needs | **create solutions** | assess solutions

OI Execution ► Who is using the OI method?
self (OI team) | delegation

Initial product ► Is an existing product required?
not required | **required**

Maturity level of solutions ► How concrete is the input?
idea (1D) | **concept (2D)** | implement. (3D)

Openess of topic ► How open is the task setting?
free | **given direction** | restricted

Kind of result ► High quality or quantity of solutions?
quality | **quantity**

Degree of innovation ► How novel are the solutions?
incremental | **radical**

Effort of Method

Learning ► effort for learning the OI method
low | high

Preparing ► effort for preparing the method
low | high

Reusing ► effort for using the method in another project
low | high | **not possible**

Executing ► effort for gaining the OI input
low | **high**

Operationalising ► effort for processing the OI input
low | **high**

Operating life ► use horizon of OI method
once | permanent

Shortest time to results ► from planning until results
days | weeks | months

Literature ► Belz, F. and Baumbach, W. (2010): 'Netnography as a method of lead user identification', Creativity and Innovation Management, vol. 19, no. 3, pp. 304–313. ► Langer, R. and Beckman, S. C. (2005): 'Sensitive research topics: netnography revisited', Qualitative Market Research: An International Journal, vol. 8, no. 2, pp. 189–203.

Toolkit (early phase)

Goal

Toolkits allows the involvement of users with technical expertise. Toolkits represent a type of simplified CAD tools, which can be intuitively used. They allow users to design their own products (within a defined solution space). The playful designing process supports users in realising their implicit needs.

Process

After implementing a simple (web-based) CAD tool users can design their own products. By this „playing“ with their products, implicit product-specific needs can be revealed. In addition, users can rate and comment on designs of other users. This allows the identification and evaluation of underlying needs and solution ideas.

Advantages

► Intuitive use by users
► Revealing implicit user needs
► Autonomous and direct designing of products by users
► Short feedback cycles for users

Disadvantages

► High effort of time and costs to implement or purchase a suitable toolkit and underlying system
► Quality and level of creativity depend on the layout and usability of the toolkit, and the defined solution space

OI Partner

Quantity ► How many OI partners are involved?
select. individuals | select. multiple | **as many as poss.**

Required knowledge ► What knowledge do they need?
no knowledge | **basic knowledge** | expert knowledge

Cooperation ► What is the type of cooperation?
pull knowledge | exchange knowl. | collaboration

Communication ► What is the type of cooperation?
virtual | face-to-face

Interaction ► Do different OI partners work together?
none | **possible** | required

Task Setting

OI Goal ► What shall be achieved by using the method?
determine needs | **create solutions** | assess solutions

OI Execution ► Who is using the OI method?
self (OI team) | delegation

Initial product ► Is an existing product required?
not required | required

Maturity level of solutions ► How concrete is the input?
idea (1D) | **concept (2D)** | implement. (3D)

Openess of topic ► How open is the task setting?
free | given direction | **restricted**

Kind of result ► High quality or quantity of solutions?
quality | **quantity**

Degree of innovation ► How novel are the solutions?
incremental | **radical**

Effort of Method

Learning ► effort for learning the OI method
low | **high**

Preparing ► effort for preparing the method
low | **high**

Reusing ► effort for using the method in another project
low | **high** | not possible

Executing ► effort for gaining the OI input
low | high

Operationalising ► effort for processing the OI input
low | **high**

Operating life ► use horizon of OI method
once | permanent

Shortest time to results ► from planning until results
days | **weeks** | months

Literature ► Reichwald, R. and Piller, F. T. (2009): Interaktive Wertschöpfung, 2nd edn, Wiesbaden, Germany: Gabler, p. 189f. ► Hippel, E. von and Katz, R. (2002): 'Shifting innovation to users via toolkits', Management Science, vol. 48, no. 7, pp. 821–833.

Toolkit (late phase)

Goal

Toolkits represent a type of simplified CAD tools, which can be intuitively used. They allow users to design their own products within a defined solution space (which is broader than of traditional configurators). Via specific interfaces the designed product models can be transferred into the production process.

Process

After implementing a simple (web-based) CAD tool users can design their own products. By this „playing" with their products, implicit product-specific needs can be revealed. In addition, users can rate and comment on designs of other users. This allows the identification and evaluation of underlying needs and solution ideas.

Advantages

- Individual products for a multitude of users
- Trial-and-error based design can reveal implicit user needs
- Long-term application possible
- Direct link with production possible

Disadvantages

- High effort of time and costs to implement or purchase a suitable toolkit and underlying system
- Quality and level of creativity depend on the layout and usability of the toolkit, and the defined solution space
- Link with production requires flexible prod. processes

OI Partner

Quantity ► How many OI partners are involved?
select. individuals | select. multiple | as many as poss.

Required knowledge ► What knowledge do they need?
no knowledge | basic knowledge | expert knowledge

Cooperation ► What is the type of cooperation?
pull knowledge | exchange knowl. | collaboration

Communication ► What is the type of cooperation?
virtual | face-to-face

Interaction ► Do different OI partners work together?
none | possible | required

Task Setting

OI Goal ► What shall be achieved by using the method?
determine needs | create solutions | assess solutions

OI Execution ► Who is using the OI method?
self (OI team) | delegation

Initial product ► Is an existing product required?
not required | required

Maturity level of solutions ► How concrete is the input?
idea (1D) | concept (2D) | implement. (3D)

Openess of topic ► How open is the task setting?
free | given direction | restricted

Kind of result ► High quality or quantity of solutions?
quality | quantity

Degree of innovation ► How novel are the solutions?
incremental | radical

Effort of Method

Learning ► effort for learning the OI method
low | high

Preparing ► effort for preparing the method
low | high

Reusing ► effort for using the method in another project
low | high | not possible

Executing ► effort for gaining the OI input
low | high

Operationalising ► effort for processing the OI input
low | high

Operating life ► use horizon of OI method
once | permanent

Shortest time to results ► from planning until results
days | weeks | months

Literature ► Kamis, A., Koufaris, M. and Stern, T. (2008): 'Using an attribute-based decision support system for user-customized products online: An experimental Investigation.', MIS Quarterly, vol. 32, no. 1, pp. 159–177. ► Diener, K. and Piller, F. T. (2009): 'The market for Open Innovation increasing the efficiency and effectiveness of the innovation process', Aachen RWTH Aachen University, p. 18.

13.7 Open Innovation risks

13.7.1 Partner-specific chances and risks

Chances	Risks and barriers
Universities (HYLL AND PIPPEL 2016, p. 465; PERKMANN et al. 2011, p. 204f)	
• leverage of their R&D funding • access to basic scientific knowledge • improving their problem solving capability • access to new technologies and techniques • access to potential recruits • access to other companies in the context of joint research projects	• IP (universities focus on openly publishing of research results, while companies aim for protective strategies) • temporal issues (universities tend to have a curiosity-driven long-term perspective, while companies often have a cost-driven short-term perspective) • mentality (universities focus on scientific and companies on economic value gains) • specific regulations of universities and public sponsors can be disadvantageous
Competitors (HYLL AND PIPPEL 2016, p. 464)	
• relevant for product and process innovations • similar needs and goals • valuable base of experience • chance to share costs and risks within the project • increased power for setting industry standards	• rivals • urge to protect knowledge • low motivation to share knowledge • innovations usually require differences instead of commonalities
Suppliers (HYLL AND PIPPEL 2016, p. 464)	
• relevant for product and process innovations • relevant for mutual understanding of needs and capabilities • success of OEM increases sales of supplier • easy access to knowledge of supplier • sharing of development risks • shortening of developing time	• dependencies (particularly when single sourcing) • less innovative solutions
Customers (HYLL AND PIPPEL 2016, p. 465)	
• relevant for product innovations • information about deficits of existing products • high motivation as future product users • early customer feedback reduces risk of product failures • the aspect "know best about their needs" should be reflected carefully	• often no knowledge what they really want or need • "tacit knowledge"
Consultants (HYLL AND PIPPEL 2016, p. 465)	
• different backgrounds allow a variety of knowledge • external perspective allows to identify potential challenges and improvements	• risk of project failures if companies have unrealistic expectations • often insufficient knowledge exchange as consultants often also work with competitors
Other companies in the same enterprise group (HYLL AND PIPPEL 2016, p. 465f)	
• within the same enterprise group • similar needs and goals • low need for secrecy	• often not supported due to enterprise policy

13.7.2 Phase-specific Open Innovation risks

Phase of collaboration process	**Risks**
Identification of partners	limitation to incremental innovation
Start of collaboration	focus on niche markets
Design phase	dependent on customer (ideas, demands and perception)
Collaboration phase	misunderstandings between internal and external partners
End of collaboration	loss of knowhow and knowledge

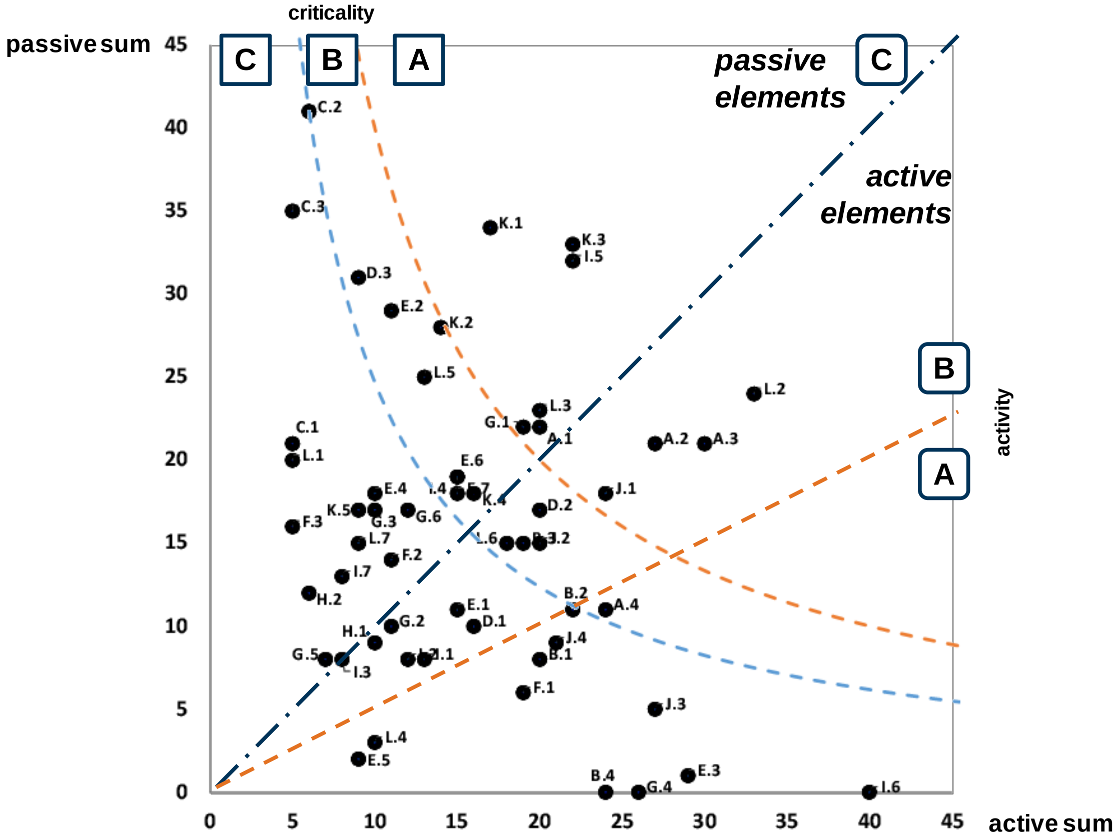
Source: ENKEL et al. (2005a, p. 205)

13.7.3 Crowdsourcing-specific risks

	Risk	**Measure**	**Side effects of measure**
Strategic risks	Revealing business and innovation strategy	Anonymously publishing the task description	No improved PR as innovative company
		Publishing a detail task that allows no conclusion to the overall innovation strategy	Requires precise task description to gain useful results
		Only publishing of tasks outside of strategic core competences	Exclusion of potentially interesting tasks
		Taking the risk	Risks depending on innovation cycles in specific industries
Followers risk	Investing in business ideas that are already known to competitors	Closed ideation contest: participants cannot see ideas of each other	Participants cannot cooperate and evaluate each other
		Publishing tasks in early phases of the innovation process since resulting products strongly differ from early ideas	Risk of reduced level of maturity and details of gained OI input
Patents risk	Publishing of internal ideas that cannot be patented any longer	Closed ideation contest: participants cannot see ideas of each other	Participants cannot cooperate and evaluate each other

Source: GASSMANN (2013, p. 37)

13.7.4 Structural analysis of risk dependencies



A	Uncontrolled Knowledge Drain
A.1	Knowledge Drain by Collaboration
A.2	Knowledge Drain and Loss by Disloyal Partner
A.3	Fear of Knowledge Drain (NSH and NIH)
A.4	Loss of Competencies
B	**IP and Law**
B.1	Complex Ownership of OI Input
B.2	OI Partners Claim IP Rights
B.3	Increased Complexity of IP Management
B.4	International Differences in Regulations
C	**Benefit-Cost Ratio**
C.1	Limitation to Incremental Innovations…
C.2	Short Timed Success
C.3	Insufficient Turnover & Disinvestments
D	**No Suitable OI-Actor**
D.1	Relevant OI-Actors Not Identified
D.2	Suitable OI-Actor Not Selected
D.3	Preferring Existing Partners
E	**Increased Complexity**
E.1	Increased Interface Complexity of Inno. Process
E.2	Increased Administration Effort and Complexity
E.3	No Guideline on Implementation
E.4	Insufficient Balancing of OI and Daily Business
E.5	Increased Product Complexity
E.6	Loss of Control
E.7	Unpredictability of Process and Outcome

F	Dependence on OI-Actors
F.1	Dependence on OI Actors' Capabilities
F.2	Discontinuous Supply of External Knowledge
F.3	Targeting a Minority or Niche Market
G	**Collaboration & Organisational Barriers**
G.1	Wrong Cooperation Type with OI Actors
G.2	Inadequate Communication Techn. or Infrastr.
G.3	Misconception of Customer Needs
G.4	Global Distribution of OI Actors
G.5	Inflexible Partner
G.6	Company's Externals Cannot Find Access
H	**Increased Competition…**
H.1	Increased Competition
H.2	Missing Differentiation to Competitors
I	**Operational Risk**
I.1	Missing Time Resources
I.2	Missing Financial Resources
I.3	Missing Material Resources
I.4	Misevaluation of External Input
I.5	Missing Management Support
I.6	Missing Base or Experienced Knowledge of OI
I.7	Insufficient Absorptive Capacity

J	Communication and Cultural Barriers
J.1	Misunderstandings Between OI Actors
J.2	Insufficient Communication Between OI Actors
J.3	Culture Clash
J.4	Inadequate Expect. & Interests from OI-Actors
K	**Incentives (Internal and External)**
K.1	Missing Motivation from OI Actors
K.2	Missing Identification with Project (NIH)
K.3	Resistance to Change (NIH)
K.4	Fear of Losing Innovation Ability (NIH)
K.5	External Input is Seen as Worthless (NIH)
L	**Strategic Risks**
L.1	Project not Suitable for Open Innovation
L.2	Wrong Decisions in OI Planning
L.3	Wrong Degree of Openness
L.4	Overestimating Open Innovation
L.5	Understating Open Innovation
L.6	Low Technological Aggressiveness
L.7	Missing Knowledge of Market Needs

Figure 13-5: Risk Influence Portfolio (based on: GUERTLER et al. 2015d, p. 5)

13.7.5 Structural ABC-analysis of risk relevance

	Activity	Activity	Delta	Cum. Value	Cum. No.
B.4	International Differences in Regulations	N/A			2%
G.4	Global Distribution of OI Actors	N/A			4%
I.6	Missing Base or Experienced Knowledge of OI	N/A			5%
E.3	No Guideline on Implementation	29,0	0%	32%	7%
J.3	Culture Clash	5,4	-81%	38%	9%
E.5	Increased Product Complexity	4,5	-17%	43%	11%
L.4	Overestimating Open Innovation	3,3	-26%	47%	13%
F.1	Dependence on OI Actors' Capabilities	3,2	-5%	50%	15%
B.1	Complex Ownership of OI Input	2,5	-21%	53%	16%
J.4	Inadequate Expect. & Interests from OI-Actors	2,3	-7%	56%	18%
A.4	Loss of Competencies	2,2	-6%	58%	20%
B.2	OI Partners Claim IP Rights	2,0	-8%	60%	22%
I.1	Missing Time Resources	1,6	-19%	62%	24%
D.1	Relevant OI-Actors Not Identified	1,6	-2%	64%	25%
I.2	Missing Financial Resources	1,5	-6%	65%	27%
A.3	Fear of Knowledge Drain (NSH and NIH)	1,4	-5%	67%	29%
L.2	Wrong Decisions in OI Planning	1,4	-4%	68%	31%
E.1	Increased Interface Complexity of Inno. Process	1,4	-1%	70%	33%
J.1	Misunderstandings Between OI Actors	1,3	-2%	71%	35%
J.2	Insufficient Communication Between OI Actors	1,3	0%	73%	36%
A.2	Knowledge Drain and Loss by Disloyal Partner	1,3	-4%	74%	38%
B.3	Increased Complexity of IP Management	1,3	-1%	76%	40%
L.6	Low Technological Aggressiveness	1,2	-5%	77%	42%
D.2	Suitable OI-Actor Not Selected	1,2	-2%	78%	44%
H.1	Increased Competition	1,1	-6%	80%	45%
G.2	Inadequate Communication Techn. or Infrastr.	1,1	-1%	81%	47%
I.3	Missing Material Resources	1,0	-9%	82%	49%
A.1	Knowledge Drain by Collaboration	0,9	-9%	83%	51%
K.4	Fear of Losing Innovation Ability (NIH)	0,9	-2%	84%	53%
G.5	Inflexible Partner	0,9	-2%	85%	55%
L.3	Wrong Degree of Openness	0,9	-1%	86%	56%
G.1	Wrong Cooperation Type with OI Actors	0,9	-1%	87%	58%
E.7	Unpredictability of Process and Outcome	0,8	-4%	88%	60%
E.6	Loss of Control	0,8	-5%	89%	62%
I.4	Misevaluation of External Input	0,8	0%	89%	64%
F.2	Discontinuous Supply of External Knowledge	0,8	0%	90%	65%
G.6	Company's Externals Cannot Find Access	0,7	-10%	91%	67%
I.5	Missing Management Support	0,7	-3%	92%	69%
K.3	Resistance to Change (NIH)	0,7	-3%	93%	71%
I.7	Insufficient Absorptive Capacity	0,6	-8%	93%	73%
L.7	Missing Knowledge of Market Needs	0,6	-3%	94%	75%
G.3	Misconception of Customer Needs	0,6	-2%	95%	76%
E.4	Insufficient Balancing of OI and Daily Business	0,6	-6%	95%	78%
K.5	External Input is Seen as Worthless (NIH)	0,5	-5%	96%	80%
L.5	Understating Open Innovation	0,5	-2%	96%	82%
H.2	Missing Differentiation to Competitors	0,5	-4%	97%	84%
K.1	Missing Motivation from OI Actors	0,5	0%	98%	85%
K.2	Missing Identification with Project (NIH)	0,5	0%	98%	87%
E.2	Increased Administration Effort and Complexity	0,4	-24%	98%	89%
F.3	Targeting a Minority or Niche Market	0,3	-18%	99%	91%
D.3	Preferring Existing Partners	0,3	-7%	99%	93%
L.1	Project not Suitable for Open Innovation	0,3	-14%	99%	95%
C.1	Limitation to Incremental Innovations…	0,2	-5%	100%	96%
C.2	Short Timed Success	0,1	-39%	100%	98%
C.3	Insufficient Turnover & Disinvestments	0,1	-2%	100%	100%
C.3	Insufficient Turnover & Disinvestments	0,1	-2%	100%	100%

	Criticality	Criticality	Delta	Cum. Value	Cum. No.
L.2	Wrong Decisions in OI Planning	792	0%	6%	2%
K.3	Resistance to Change (NIH)	726	-8%	11%	4%
I.5	Missing Management Support	704	-3%	17%	5%
A.3	Fear of Knowledge Drain (NSH and NIH)	630	-11%	21%	7%
K.1	Missing Motivation from OI Actors	578	-8%	26%	9%
A.2	Knowledge Drain and Loss by Disloyal Partner	567	-2%	30%	11%
L.3	Wrong Degree of Openness	460	-19%	33%	13%
A.1	Knowledge Drain by Collaboration	440	-4%	37%	15%
J.1	Misunderstandings Between OI Actors	432	-2%	40%	16%
G.1	Wrong Cooperation Type with OI Actors	418	-3%	43%	18%
K.2	Missing Identification with Project (NIH)	392	-6%	46%	20%
D.2	Suitable OI-Actor Not Selected	340	-13%	48%	22%
L.5	Understating Open Innovation	325	-4%	51%	24%
E.2	Increased Administration Effort and Complexity	319	-2%	53%	25%
J.2	Insufficient Communication Between OI Actors	300	-6%	55%	27%
K.4	Fear of Losing Innovation Ability (NIH)	288	-4%	58%	29%
B.3	Increased Complexity of IP Management	285	-1%	60%	31%
E.6	Loss of Control	285	0%	62%	33%
I.4	Misevaluation of External Input	285	0%	64%	35%
D.3	Preferring Existing Partners	279	-2%	66%	36%
E.7	Unpredictability of Process and Outcome	270	-3%	68%	38%
L.6	Low Technological Aggressiveness	270	0%	70%	40%
A.4	Loss of Competencies	264	-2%	72%	42%
C.2	Short Timed Success	246	-7%	74%	44%
B.2	OI Partners Claim IP Rights	242	-2%	76%	45%
G.6	Company's Externals Cannot Find Access	204	-16%	77%	47%
J.4	Inadequate Expect. & Interests from OI-Actors	189	-7%	79%	49%
E.4	Insufficient Balancing of OI and Daily Business	180	-5%	80%	51%
C.3	Insufficient Turnover & Disinvestments	175	-3%	81%	53%
G.3	Misconception of Customer Needs	170	-3%	83%	55%
E.1	Increased Interface Complexity of Inno. Process	165	-3%	84%	56%
B.1	Complex Ownership of OI Input	160	-3%	85%	58%
D.1	Relevant OI-Actors Not Identified	160	0%	86%	60%
F.2	Discontinuous Supply of External Knowledge	154	-4%	87%	62%
K.5	External Input is Seen as Worthless (NIH)	153,0	-1%	89%	64%
J.3	Culture Clash	135	-12%	90%	65%
L.7	Missing Knowledge of Market Needs	135	0%	91%	67%
F.1	Dependence on OI Actors' Capabilities	114	-16%	91%	69%
G.2	Inadequate Communication Techn. or Infrastr.	110	-4%	92%	71%
C.1	Limitation to Incremental Innovations…	105	-5%	93%	73%
I.1	Missing Time Resources	104	-1%	94%	75%
I.7	Insufficient Absorptive Capacity	104	0%	95%	76%
L.1	Project not Suitable for Open Innovation	100	-4%	95%	78%
I.2	Missing Financial Resources	96	-4%	96%	80%
H.1	Increased Competition	90	-6%	97%	82%
F.3	Targeting a Minority or Niche Market	80	-11%	97%	84%
H.2	Missing Differentiation to Competitors	72	-10%	98%	85%
I.3	Missing Material Resources	64	-11%	98%	87%
G.5	Inflexible Partner	56	-13%	99%	89%
I.6	Missing Base or Experienced Knowledge of OI	40	-29%	99%	91%
L.4	Overestimating Open Innovation	30	-25%	99%	93%
E.3	No Guideline on Implementation	29	-3%	99%	95%
G.4	Global Distribution of OI Actors	26	-10%	100%	96%
B.4	International Differences in Regulations	24	-8%	100%	98%
E.5	Increased Product Complexity	18	-25%	100%	100%
G.3	Misconception of Customer Needs	10	-44%	100%	100%

	Active-Criticality	AS^2 * PS	Delta	Cum. Value	Cum. No.
L.2	Wrong Decisions in OI Planning	26.136	0%	11%	2%
A.3	Fear of Knowledge Drain (NSH and NIH)	18.900	-28%	18%	4%
K.3	Resistance to Change (NIH)	15.972	-15%	25%	5%
I.5	Missing Management Support	15.488	-3%	31%	7%
A.2	Knowledge Drain and Loss by Disloyal Partner	15.309	-1%	37%	9%
J.1	Misunderstandings Between OI Actors	10.368	-32%	41%	11%
K.1	Missing Motivation from OI Actors	9.826	-5%	45%	13%
L.3	Wrong Degree of Openness	9.200	-6%	49%	15%
A.1	Knowledge Drain by Collaboration	8.800	-4%	52%	16%
G.1	Wrong Cooperation Type with OI Actors	7.942	-10%	55%	18%
D.2	Suitable OI-Actor Not Selected	6.800	-14%	58%	20%
A.4	Loss of Competencies	6.336	-7%	61%	22%
J.2	Insufficient Communication Between OI Actors	6.000	-5%	63%	24%
K.2	Missing Identification with Project (NIH)	5.488	-9%	65%	25%
B.3	Increased Complexity of IP Management	5.415	-1%	68%	27%
B.2	OI Partners Claim IP Rights	5.324	-2%	70%	29%
L.6	Low Technological Aggressiveness	4.860	-9%	72%	31%
K.4	Fear of Losing Innovation Ability (NIH)	4.608	-5%	74%	33%
E.6	Loss of Control	4.275	-7%	75%	35%
I.4	Misevaluation of External Input	4.275	0%	77%	36%
L.5	Understating Open Innovation	4.225	-1%	79%	38%
E.7	Unpredictability of Process and Outcome	4.050	-4%	80%	40%
J.4	Inadequate Expect. & Interests from OI-Actors	3.969	-2%	82%	42%
J.3	Culture Clash	3.645	-8%	83%	44%
E.2	Increased Administration Effort and Complexity	3.509	-4%	85%	45%
B.1	Complex Ownership of OI Input	3.200	-9%	86%	47%
D.1	Relevant OI-Actors Not Identified	2.560	-20%	87%	49%
D.3	Preferring Existing Partners	2.511	-2%	88%	51%
E.1	Increased Interface Complexity of Inno. Process	2.475	-1%	89%	53%
G.6	Company's Externals Cannot Find Access	2.448	-1%	90%	55%
F.1	Dependence on OI Actors' Capabilities	2.166	-12%	91%	56%
E.4	Insufficient Balancing of OI and Daily Business	1.800	-17%	92%	58%
G.3	Misconception of Customer Needs	1.700	-6%	92%	60%
F.2	Discontinuous Supply of External Knowledge	1.694	0%	93%	62%
I.6	Missing Base or Experienced Knowledge of OI	1600,0	-6%	94%	64%
C.2	Short Timed Success	1.476	-8%	94%	65%
K.5	External Input is Seen as Worthless (NIH)	1.377	-7%	95%	67%
I.1	Missing Time Resources	1.352	-2%	95%	69%
L.7	Missing Knowledge of Market Needs	1.215	-10%	96%	71%
G.2	Inadequate Communication Techn. or Infrastr.	1.210	0%	96%	73%
I.2	Missing Financial Resources	1.152	-5%	97%	75%
H.1	Increased Competition	900	-22%	97%	76%
C.3	Insufficient Turnover & Disinvestments	875	-3%	98%	78%
E.3	No Guideline on Implementation	841	-4%	98%	80%
I.7	Insufficient Absorptive Capacity	832	-1%	98%	82%
G.4	Global Distribution of OI Actors	676	-19%	98%	84%
B.4	International Differences in Regulations	576	-15%	99%	85%
C.1	Limitation to Incremental Innovations…	525	-9%	99%	87%
I.3	Missing Material Resources	512	-2%	99%	89%
L.1	Project not Suitable for Open Innovation	500	-2%	99%	91%
H.2	Missing Differentiation to Competitors	432	-14%	99%	93%
F.3	Targeting a Minority or Niche Market	400	-7%	100%	95%
G.5	Inflexible Partner	392	-2%	100%	96%
L.4	Overestimating Open Innovation	300	-23%	100%	98%
E.5	Increased Product Complexity	162	-46%	100%	100%
G.3	Misconception of Customer Needs	100	-38%	100%	100%

Figure 13-6: Structural ABC-analysis of OI risks (GUERTLER et al. 2015d)

13.8 Motivational factors as basis of incentive strategies

Table 13-11: Intrinsic and extrinsic motivational factors (based on: KIRSCHNER 2012, p. 58)

Intrinsic motivational factors	Extrinsic motivational factors
Altruism	compensation (material, immaterial)
Identification with task and goal	expected benefits
Fun and dissipation in solving a task	need for a solution of a specific task
Contributing to team goals	gain of reputation
Self-efficacy	importance of a task
Ideology	improvement of an existing solution
Flow experience	economic stimulus, money
Satisfaction with a task	improved human capital
Hedonism	
Self-representation	

13.9 Feedback of the participating industry partners

This chapter comprises the feedback questionnaires of the three industry partners and their individual experience of applying the methodology SOI in the context of the project *KME – Open Innovation*. Along with observations of the author and direct discussions with the industry partners in the context of regular project meetings, this feedback is the basis of the evaluation of SOI.

The questionnaires were left in German and were not edited, in order to preserve the statements of the industry partners and prevent translation biases.

13.9.1 Feedback company 1

The questionnaire was answered by the entire OI team.

General feedback (1)

	Trifft überhaupt nicht zu			**Triff komplett zu**
Die Planungsmethodik bietet unerfahrenen Anwendern operative und systematische ***Unterstützung*** *bei der OI-Projektplanung.*	☐	☐	☐	☒
Die Planungsmethodik hat zu einem ***besseren Ver-ständnis von Open Innovation*** *beigetragen.*	☐	☐	☒	☐
Die Planungsmethodik lässt sich gut an die jeweiligen ***Randbedingungen anpassen*** *(d.h. adaptieren, skalieren)*	☐	☐	☐	☒
Der ***Zweck und Ziel*** *der einzelnen Planungsschritte wird verständlich beschrieben.*	☐	☐	☐	☒
Der notwendige ***Aufwand*** *und zu erwartende* ***Mehrwert*** *werden verständlich beschrieben.*	☐	☐	☐	☒
Der erzielte Mehrwert war den ***Aufwand wert****.*	☐	☐	☒	☐
Die Planungsmethodik hat geholfen, implizites Wissen aufzudecken und zu einem ***homogenen Wissenslevel*** *im Planungsteam des Unternehmens beigetragen.*	☐	☐	☒	☐
Die Planungsmethodik hat unterstützt, etablierte Ansichten, Prozesse usw. kritisch zu hinterfragen.	☐	☐	☐	☒
Die Planungsmethodik hat eine abteilungs-/ ***bereichsübergreifende Zusammenarbeit*** *unterstützt.*	☐	☐	☒	☐
Die Planungsmethodik hat geholfen bei der ***Sensibilisierung für mögliche Projektrisiken*** *und Barrieren.*	☐	☐	☐	☒
Die Planungsmethodik unterstützt eine transparente und fundierte ***Entscheidungsfindung****.*	☐	☐	☐	☒
Die Planungsmethodik unterstützt die ***Dokumentation*** *des Planungsprozesses und von Entscheidungen.*	☐	☐	☐	☒
Die Planungsmethodik wird im Unternehmen ***wieder angewendet*** *werden.*	☐	☐	☐	☒

General feedback (2)

Wie wären Sie ohne Planungsmethodik vorgegangen?

- Ohne das OI Projekt wären wir mit bereits bekannten Partnern das Projekt angegangen. Es wären keine neuen Kontakte entstanden bzw. wenn dann erst zeitverzögert, bei Stillstand des Projektes.
- Situationsanalyse wäre zumindest weniger umfangreich gestaltet worden

Können Sie die Ergebnisse der Planungsmethodik auch abseits des OI-Projekts nutzen? Wenn ja, wo?

- Situationsanalyse der Unternehmensstruktur und Zusammenhänge einmal deutlich vor Augen zu sehen ist hilfreich.
- Im internen Innovationsmanagement können die Ergebnisse implementiert werden
- Bei neuen Projekten können die Resourcen anders verplant werden, wenn andere Abteilungen systematisch einbezogen werden
- zur internen Ideengenerierung können OI-Methoden verwendet werden

Wo sehen Sie die Vorteile der Planungsmethodik?

- lineare Vorgehensweise
- Im systematischen Erarbeiten von Lösungskonzepten mit weit gesteckten Handlungsräumen

Was könnte man an der Planungsmethodik noch verbessern?

- <left blank>

Sonstige Anmerkungen:

- <left blank>

Feedback concerning the OI partner search

	Trifft überhaupt nicht zu			**Triff komplett zu**
*Die Methodik unterstützt bei der Identifizierung **externer Stakeholder**.*	☐	☐	☒	☐
*Die Methodik unterstützt bei der Identifizierung **interner Stakeholder**.*	☐	☐	☒	☐
*Durch die Methodik konnten systematisch **neue, bislang unbekannte** OI-Partnern gefunden werden.*	☐	☐	☒	☐
*Die Methodik **unterstützt bei der Auswahl** relevanter OI-Partner.*	☐	☐	☐	☒
*Die Methodik unterstützt, **Beziehungen und Abhängigkeiten zwischen Stakeholdern** besser zu verstehen.*	☐	☐	☐	☒

Optional: freie Anmerkungen zur Partnersuche:

- *Die Methode findet keine Partner. Die Suche ist immer subjektiv und vom Suchenden und seinen Bewertungen/ Erfahrungen abhängig.*
- *Stakeholderanalyse war bislang in der Form unbekannt*

Feedback concerning the selection of OI methods

	Trifft überhaupt nicht zu			**Triff komplett zu**
Die Methodik unterstützt die systematische Auswahl geeigneter OI-Maßnahmen.	☐	☐	☐	☒
Das Auswahltool läßt sich intuitiv anwenden.	☐	☐	☐	☒
Das Ranking der OI-Maßnahmen nach ihrer Eignung für die OI-Situation und OI-Partner war hilfreich.	☐	☐	☐	☒
Der Rankingprozess ist transparent.	☐	☐	☐	☒
Die Methodik (Steckbriefe) zeigt Vorteile und Nachteile der OI-Maßnahmen auf.	☐	☐	☐	☒

Optional: freie Anmerkungen zur Maßnahmenauswahl:

- *Kurzsteckbriefe hilfreich*
- *Kombination je Partner interessant*

13.9.2 Feedback company 2

The questionnaire was answered by the OI team manager.

General feedback (1)

	Trifft überhaupt nicht zu			**Triff komplett zu**
*Die Planungsmethodik bietet unerfahrenen Anwendern operative und systematische **Unterstützung** bei der OI Projektplanung.*	☐	☐	☒	☐
*Die Planungsmethodik hat zu einem **besseren Ver-ständnis von Open Innovation** beigetragen.*	☐	☐	☐	☒
*Die Planungsmethodik lässt sich gut an die jeweiligen **Randbedingungen anpassen** (d.h. adaptieren, skalieren)*	☐	☐	☒	☐
*Der **Zweck und Ziel** der einzelnen Planungsschritte wird verständlich beschrieben.*	☐	☐	☐	☐
*Der notwendige **Aufwand** und zu erwartende **Mehrwert** werden verständlich beschrieben.*	☐	☐	☒	☐
*Der erzielte Mehrwert war den **Aufwand wert**.*	☐	☐	☒	☐
*Die Planungsmethodik hat geholfen, implizites Wissen aufzudecken und zu einem **homogenen Wissenslevel** im Planungsteam des Unternehmens beigetragen.*	☐	☐	☐	☒
Die Planungsmethodik hat unterstützt, etablierte Ansichten, Prozesse usw. kritisch zu hinterfragen.	☐	☐	☐	☒
*Die Planungsmethodik hat eine abteilungs-/ **bereichsübergreifende Zusammenarbeit** unterstützt.*	☐	☐	☒	☐
*Die Planungsmethodik hat geholfen bei der **Sensibilisierung für mögliche Projektrisiken** und Barrieren.*	☐	☐	☒	☐
*Die Planungsmethodik unterstützt eine transparente und fundierte **Entscheidungsfindung**.*	☐	☒	☐	☐
*Die Planungsmethodik unterstützt die **Dokumentation** des Planungsprozesses und von Entscheidungen.*	☐	☒	☐	☐
*Die Planungsmethodik wird im Unternehmen **wieder angewendet** werden.*	☐	☐	☐	☒

General feedback (2)

Wie wären Sie ohne Planungsmethodik vorgegangen? • Es gab keine Alternativen Pläne! Geht man davon aus, dass man das Problem mit OI ohne die hier vorliegende Planungsmethodik hätte lösen wollen, hätte man sicherlich einen Dienstleister kontaktieren müssen.
Können Sie die Ergebnisse der Planungsmethodik auch abseits des OI Projekts nutzen? Wenn ja, wo? • Die Methodik kann m.E. generell verwendet werden, wenn Probleme gelöst, Geschäftsmodelle gesucht oder neue Märkte erschlossen,… werden sollen. Hierfür sollte man sich immer mit den Rahmenbedingungen (Situationsanalyse), dem Problem und somit Ziel, als auch den heranzuziehenden Akteuren beschäftigen. Für oben genannte Beispiele wurde die Methodik bereits für interne Projekte angewandt → kein echtes OI
Wo sehen Sie die Vorteile der Planungsmethodik? • Ist die Grobplanung einmal verstanden, und das ist m.E. machbar für einen „Neueinsteiger" lässt sich die Methodik wie eine Frage zuvor eben nicht nur auf reine OI Projekte anwenden. Prinzipiell öffnet es die Denkweise und beugt vor, dass man zu engstirnig agiert und Schnellschussaktionen tätigt. Wie oft steht schon eine „Lösungsidee" fest mit der man das Problem in Griff bekommt, jedoch besteht das eigentliche Problem an einer ganz anderen Stelle. Genau hier liegt die Stärke, dass man sich systematisch mit dem Thema auseinandersetzt.
Was könnte man an der Planungsmethodik noch verbessern? • Mit konkreten Beispielen (nicht abstrahierte wie sie z.B. im Projektbericht zu finden → Kapitel 6: Pilotprojekte) versehen, so dass die abstrakte Methodik mit Leben geweckt wird. • Ggf. auf die Wichtigkeit der Fragestellung in der Problemstellung hinweisen. M.E. ist dies Kernstück mit dem der Fokus auf die Problemfindung gelegt wird. Gerne einmal die Frage „links-" und „rechtsrum" formulieren sowie drehen und wenden, um verschiedene Blickwinkel zu haben. • Auch das Stichwort „Diversität" ist m.E. wichtig. Bei der Auswahl der Stakeholder sollte dies deutlich gemacht werden. Die von uns angewandte Methodik würde z.B. die Stakeholder zwar bewerten, jedoch werden dann die TOP 5 etc. ausgewählt. Wichtig wäre hier auch auf Diversität zu achten (Wertschöpfung, Hierarchie, Unternehmensgröße,…)
Sonstige Anmerkungen: • Zur Frage „Zweck und Ziel": Hier habe ich nicht angekreutzt da bereits zu viel Vorwissen durch das Projekt vorlag. Es ist schwer abzuschätzen ob die Planungsschritte wie beschrieben verständlich sind. Mir waren sie jedoch durch das Erklären verständlich und einleuchtend → 3 Punkte von 4. • Zur Frage „Aufwand": Noch haben wir das Ziel nicht erreicht. Wir haben zwar die Methode ausgewählt aber die Bewertung sollte m.E. erst nach Umsetzung erfolgen. Ich gehe jedoch davon aus, dass wir 3 Punkte gut und gern vergeben können. • Zur Frage transparente Entscheidungsfindung: Prinzipiell unterstütz diese der Leitfaden. Die „Negativbewertung" gibt es dafür, weil es auch personenabhängig ist und ggf. politisch getrieben. Das Objektive Vorgehen mit dem Leitfaden zur Lösungsfindung muss dann durchaus auf der Strecke bleiben worunter die Transparenz leidet. • Dokumentation Planungsprozess: Ich denke der Leitfaden unterstützt durch sein methodisches Vorgehen, dass man leichter den Hergang nachverfolgen kann. Allerdings hängt die Dokumentation m.E. stark vom Projektteam/-leiter ab.

Feedback concerning the OI partner search

	Trifft überhaupt nicht zu			**Triff komplett zu**
Die Methodik unterstützt bei der Identifizierung ***externer Stakeholder****.*	☐	☐	☐	☒
Die Methodik unterstützt bei der Identifizierung ***interner Stakeholder****.*	☐	☐	☐	☒
Durch die Methodik konnten systematisch ***neue, bislang unbekannte*** *OI partnern gefunden werden.*	☐	☐	☐	☒
Die Methodik ***unterstützt bei der Auswahl*** *relevanter OI partner.*	☐	☐	☒	☐
Die Methodik unterstützt, ***Beziehungen und Abhängigkeiten zwischen Stakeholdern*** *besser zu verstehen.*	☐	☒	☐	☐

Optional: freie Anmerkungen zur Partnersuche:

- *Zur letzten Frage: Die Methodik weist darauf hin, dass Abhängigkeiten bestehen. Allerdings müssen diese auch erfasst werden bzw. bekannt sein. Dies war nicht immer einfach, weshalb es hier eine „Negativbewertung“ gibt.*
- *Siehe auch Punkt „Diversität“ bei Verbesserung der Methodik unter Punkt 3 dieser Befragung*

Feedback concerning the selection of OI methods

	Trifft überhaupt nicht zu			**Triff komplett zu**
Die Methodik unterstützt die systematische Auswahl geeigneter OI Maßnahmen.	☒	☐	☐	☒
Das Auswahltool läßt sich intuitiv anwenden.	☐	☐	☒	☒
Das Ranking der OI Maßnahmen nach ihrer Eignung für die OI situation und OI partner war hilfreich.	☐	☐	☒	☐
Der Rankingprozess ist transparent.	☐	☐	☒	☐
Die Methodik (Steckbriefe) zeigt Vorteile und Nachteile der OI Maßnahmen auf.	☐	☐	☐	☒

Optional: freie Anmerkungen zur Maßnahmenauswahl:

- *Inwieweit der hier hinterlegte Algorithmus auf ein Unternehmen passt, muss dieses meines Erachtens jeweils selbst entscheiden. Allerdings helfen die Steckbriefe sowie die Excelprogrammierung mit Hinweisen (insbesondere Trigger/KO-Kriterien) gut wie man selbst nachjustieren kann oder muss. Ich denke dass jedes Unternehmen bzgl. Maßnahmen Vorlieben oder Abneigungen hat und diese so beachten kann.*

Please note: The first question actually comprises two tick marks in this case.

13.9.3 Feedback company 3

The questionnaire was answered by the initial OI team manager.

General feedback (1)

	Trifft überhaupt nicht zu			Triff komplett zu
*Die Planungsmethodik bietet unerfahrenen Anwendern operative und systematische **Unterstützung** bei der OI Projektplanung.*	☐	☐	☒	☐
*Die Planungsmethodik hat zu einem **besseren Ver-ständnis von Open Innovation** beigetragen.*	☐	☐	☐	☒
*Die Planungsmethodik lässt sich gut an die jeweiligen **Randbedingungen anpassen** (d.h. adaptieren, skalieren)*	☐	☐	☒	☐
*Der **Zweck und Ziel** der einzelnen Planungsschritte wird verständlich beschrieben.*	☐	☐	☐	☒
*Der notwendige **Aufwand** und zu erwartende **Mehrwert** werden verständlich beschrieben.*	☐	☐	☐	☒
*Der erzielte Mehrwert war den **Aufwand wert**.*	☐	☐	☐	☒
*Die Planungsmethodik hat geholfen, implizites Wissen aufzudecken und zu einem **homogenen Wissenslevel** im Planungsteam des Unternehmens beigetragen.*	☐	☐	☒	☐
Die Planungsmethodik hat unterstützt, etablierte Ansichten, Prozesse usw. kritisch zu hinterfragen.	☐	☐	☒	☐
*Die Planungsmethodik hat eine abteilungs-/ **bereichsübergreifende Zusammenarbeit** unterstützt.*	☐	☐	☐	☒
*Die Planungsmethodik hat geholfen bei der **Sensibilisierung für mögliche Projektrisiken** und Barrieren.*	☐	☐	☐	☒
*Die Planungsmethodik unterstützt eine transparente und fundierte **Entscheidungsfindung**.*	☐	☒	☐	☐
*Die Planungsmethodik unterstützt die **Dokumentation** des Planungsprozesses und von Entscheidungen.*	☐	☐	☐	☒
*Die Planungsmethodik wird im Unternehmen **wieder angewendet** werden.*	☐	☐	☐	☒

General feedback (2)

Wie wären Sie ohne Planungsmethodik vorgegangen? • Analyse – Konzeption – Fallbeispiel wobei • die Findung von Konzeptbausteinen überwiegend auf Brainstorming und eigenem Erfahrungswissen beruht hätte • und genau deshalb die wertvollsten Inhalte/Inputs/Stakeholder nicht erkannt worden wären.
Können Sie die Ergebnisse der Planungsmethodik auch abseits des OI Projekts nutzen? Wenn ja, wo? • Bei allem, was neu bzw. weiter entwickelt wird und das bedeutet nicht zwangsläufig Produktentwicklung nur im technischen Sinn. • Man kann die Methodik auch im Rahmen neuer Geschäftsmodelle mit unterschiedlichen Stakeholdern einsetzen.
Wo sehen Sie die Vorteile der Planungsmethodik? • Durchgängigkeit • Vollständigkeit • Das wichtigste: Einbeziehung und Gewichtung fremder Akteure ist gewährleistet (Stakeholder, „outside-in“)
Was könnte man an der Planungsmethodik noch verbessern? • IT-gestützte Führung wie bei Programmen zur Steuererklärung
Sonstige Anmerkungen: • <left blank>

Feedback concerning the OI partner search

	Trifft überhaupt nicht zu			Triff komplett zu
*Die Methodik unterstützt bei der Identifizierung **externer Stakeholder**.*	☐	☐	☐	☒
*Die Methodik unterstützt bei der Identifizierung **interner Stakeholder**.*	☐	☐	☐	☒
*Durch die Methodik konnten systematisch **neue, bislang unbekannte** OI partnern gefunden werden.*	☐	☐	☐	☒
*Die Methodik **unterstützt bei der Auswahl** relevanter OI partner.*	☐	☐	☐	☒
*Die Methodik unterstützt, **Beziehungen und Abhängigkeiten zwischen Stakeholdern** besser zu verstehen.*	☐	☐	☒	☐

Optional: freie Anmerkungen zur Partnersuche:

- *<left blank>*

Feedback concerning the selection of OI methods

	Trifft überhaupt nicht zu			Triff komplett zu
Die Methodik unterstützt die systematische Auswahl geeigneter OI Maßnahmen.	☐	☐	☐	☒
Das Auswahltool läßt sich intuitiv anwenden.	☐	☒	☐	☐
Das Ranking der OI Maßnahmen nach ihrer Eignung für die OI situation und OI partner war hilfreich.	☐	☐	☐	☒
Der Rankingprozess ist transparent.	☐	☐	☒	☐
Die Methodik (Steckbriefe) zeigt Vorteile und Nachteile der OI Maßnahmen auf.	☐	☐	☒	☐

Optional: freie Anmerkungen zur Maßnahmenauswahl:

- *<left blank>*

14. List of dissertations

Chair of Product Development

Technical University of Munich (TUM), Boltzmannstraße 15, 85748 Garching, Germany

Dissertations supervised by:

- Prof. Dr.-Ing. W. Rodenacker,
- Prof. Dr.-Ing. K. Ehrlenspiel and
- Prof. Dr.-Ing. U. Lindemann

D1 COLLIN, H.:
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D2 OTT, J.:
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D3 STEINWACHS, H.:
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D6 SCHEITENBERGER, H.:
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D7 BAUMGARTH, R.:
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D16 BALKEN, J.:
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D18 BAUMANN, G.:
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D19 FISCHER, D.:
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