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Torn between risks and chances – What is the optimum point of openness in the R&D process? Developing Strategies for an open R&D process

Alexander Lang*

Technische Universität München, Boltzmannstr. 15, 85748 Garching bei München, Germany.
E-mail: alang@iman-solutions.de

Michael N. du Maire

Technische Universität München, Boltzmannstr. 15, 85748 Garching bei München, Germany.
E-mail: dumaire.michael@mytum.de
* Corresponding author

Abstract: In the context of expanding globalization and international trade, pressure on world-wide operating companies increases to find innovate products and services, which meet the market needs. To increase companies' innovativeness, the literatures and empirical research have concluded that openness of organizational structures in R&D environments fosters innovative performance. But how far should a company open up their R&D process? By looking at the collaboration within the R&D process in companies with different partners on the one hand and the risks and changes in the opening process on the other hand, this paper deducts relevant recommendations. Recommendations which will help companies define their own strategy in the transformation process from close to open. This will be done by using a newly developed model, which makes it possible to calculate gaps between a directly measured real openness and a calculated virtual openness using risks and chances occurring when transforming the companies from close to open.

Keywords: Open Innovation; R&D processes; collaboration; organizational openness; Open Organization

1 Introduction

Globalization is an unstoppable phenomenon. Looking at the amount of worldwide exports, the numbers show a continuous growth since 1950, except for 1974 and 2009 (BUNDESZENTRALE FÜR POLITISCHE BILDUNG, 2016). Despite the decision of the UK citizens to leave the European Union and the election of the new US President in November 2016 the reduction of international trade regulations will continue. The costs for international transportation will also continue to decrease. The lowest level of the Baltic Dry Index, an economic indicator of moving the major raw materials by sea, that was ever noticed, was reached on Feb 10th, 2016, when the index dropped to 290 points (ibid). CETA seems to be in place and other agreements will follow. Especially for the companies in export orientated, highly developed countries pressure will increase. For those companies with high cost structures, innovation will become even more important to survive. But what makes companies more innovative? The literature names many KPIs, which can be organized by a framework using the 4 cornerstones: Culture, Strategy, Processes and Tools (WASTIAN ET AL. 2009). This paper will focus on the issue of strategies and the recommendations derived for the management in companies in order to increase their innovativeness.

2 Problem

According to a study performed by CHESBROUGH & BRUNSWICKER in 2013 on the implementation of Open Innovation in large companies, 78% of the interviewed enterprises have adopted some Open Innovation approaches or are currently doing so. The majority of these companies see a variety of positive aspects when opening innovation processes. Additionally, the intensity of Open Innovation activities as well as the support for these from top level management have increased in recent years (CHESBROUGH & BRUNSWICKER 2013).

Despite these facts, the success of Open Innovation projects is seen very critically by the companies. Being asked to rate the success level of existing Open Innovation approaches in their own company on a scale from 1 (poor) to 7 (very good), representatives on average rated only 3.73 (CHESBROUGH & BRUNSWICKER 2013). This, contradicting the positive view on chances Open Innovation could offer, led to the question where exactly the gap between concept and successful implementation is situated. According to the managers interviewed, the most challenging needs for action are the management of internal organizational change towards a structure that fosters open R&D approaches and the proactive design of external relationships with collaboration partners. Strikingly, these needs for action have not changed much in the years after the study carried-out in 2013 (CHESBROUGH & BRUNSWICKER 2013). It seems that neither research nor management theory have yet provided enterprises with hands-on knowledge for the successful implementation of open R&D approaches and the structures and processes necessary to support them.

TUSHMAN ET AL. (2012) and HERSTAD ET AL. (2008) have reported similar findings regarding organizational structures and Open Innovation, stating that open processes cannot be successfully implemented into a somewhat closed organizational environment. Therefore they call for a willingness to open the R&D processes.
In the proceedings of their study, CHESBROUGH & BRUNSWICKER (2013) conclude that

> *"Open Innovation is a systemic shift that requires re-thinking many aspects of one's business to utilize it effectively"* (CHESBROUGH & BRUNSWICKER 2013, page 37).

The primary locus of the need for action in the process of opening up collaborative generation of innovations is the R&D environment of a company, as this will be primarily affected by Open Innovation approaches. This organizational location needs to be addressed first to start the intra-organizational change as most activities linked to Open Innovation activities are located in this organizational context.

When developing recommendations for opening strategies, it has to be kept in mind that change processes always generate positive and negative aspects. Besides the chances those change processes offer, there are always risks that the companies have to take. Research on Open Innovation focuses mainly on the chances when implementing the new processes.

While these positive aspects certainly exist also the possible downsides of opening R&D activity have to be considered as ULLRICH & VLADOVA (2016) state. In the study on Open Innovation in large companies mentioned above, several risks can be identified that come along with the opening process. These are primarily missing IP protection and loss of knowledge as well as the missing capabilities to absorb the knowledge generated through collaborating with others (CHESBROUGH & BRUNSWICKER 2013).

In order to set an ideal point of openness, LANG ET AL. (2016) have introduced a framework which defines factors which have a positive and a negative characteristic when implementing more open processes. Looking at the risks and chances helps to define the ideal point of openness. Also, DAHLANDER & GANN (2010) state that Open Innovation approaches can be supported in a variety of different settings of openness which shows that *more open* may not always lead to the desired direction of development. Even earlier, LAURSEN & SALTER (2006) have shown that in fact increasing openness of R&D processes only fosters innovation success until a certain degree of openness is reached and declines afterwards. This behaviour became known as the inverted u-shape of openness and is shown in Figure 1. Looking at the plotted graph in the diagram, the assumption can be made that there is an optimum of openness which may vary depending on situations and companies (LAURSEN & SALTER, 2006).

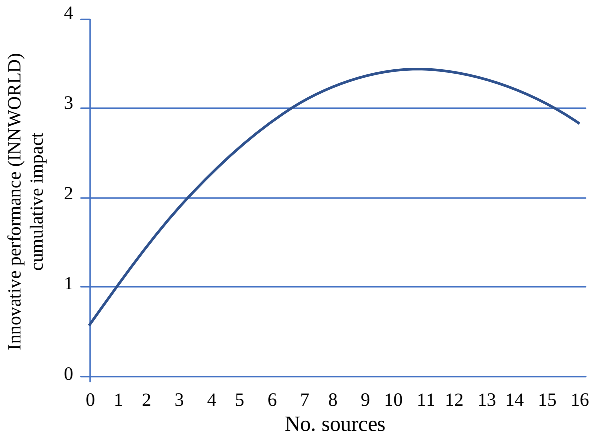

Figure 1 – predicted relationship between innovative performance and the breadth of search through external sources of innovation (LAURSEN & SALTER 2006)

Following this argumentation, LANG ET AL. (2016) have suggested to define the current degree of openness (Real Openness, RO) in the collaboration of companies with internal and external partners. Moreover, they calculated the Virtual Openness (VO) by using the risks and chances within this collaboration. In order to find the perfect spot of openness, the Ideal Openness (IO) they use the gap between the RO and VO. The gap points to problem areas and helps define recommendations as a foundation for the strategy development process.

The question remaining, which according to CHESBROUGH'S & BRUNSWICKER'S findings intrigues innovation managers in the context of Open Innovation, is what exactly can be done to address these needs. Therefore, this paper, on the basis of the findings of LANG ET AL. (2016) will outline a novel method for identifying concrete recommendations on specific problem fields of collaboration. This leads to the formulation of the research question which shall be answered in this paper.

3 Research Question

Having developed a methodology on how to find the ideal openness previously, the focus here will be on the development of a general set of recommendations on how to behave in the context of collaboration with internal and external partners.

4 Research Design

Column model of collaboration and real openness

Analysing different possible collaboration scenarios, LANG (2015) has introduced the column model of collaboration which separates partners into ten different categories.

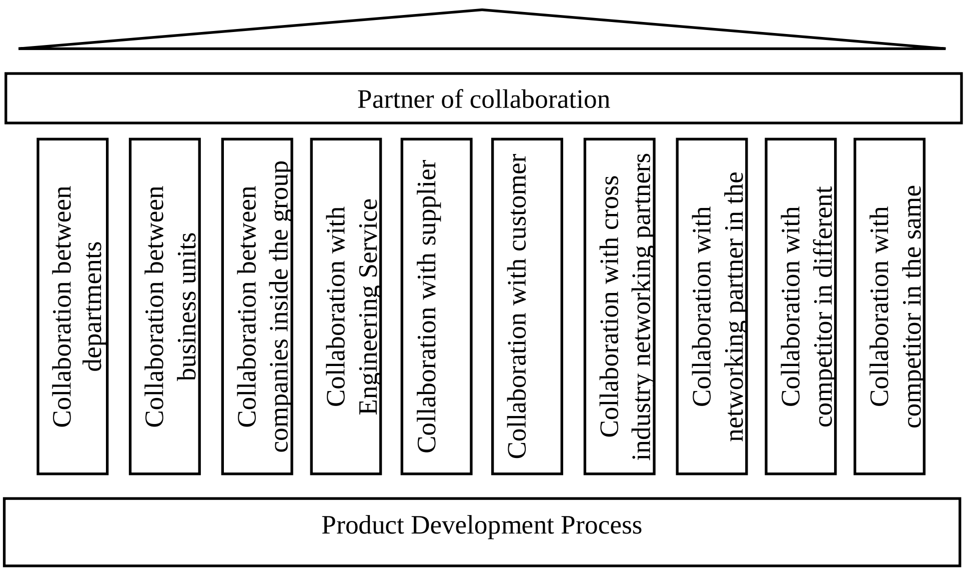

Figure 2 – The Column Modell of Collaboration (LANG 2015)

The ten different collaboration partners, who can be grouped in 3 clusters, internal, partners, and pears, are:

- Collaboration between employees from different departments inside the company
- Collaboration between employees from different business units
- Collaboration between employees from different companies inside the group
- Collaboration of the company with external partners: Engineering Service Provider
- Collaboration of the company with external partners: Supplier
- Collaboration of the company with external partners: Customers
- Collaboration of the company with networking partners: Cross Industry
- Collaboration of the company with networking partners: Same Industry
- Collaboration of the company with networking partners: Competitors in different markets
- Collaboration of the company with networking partners: Competitors in the same market

(LANG 2015)

Using these categories, 20 German manufacturing companies were asked about how openly they interact with each of their partners in R&D collaboration using a percentage scale. Values could therefore range from 0% (no collaboration) to 100% (fully open collaboration). To simplify the determination of this actual degree of openness, two criteria were used: the occurrence of interaction and the level of trust in the collaboration.

Influenced Factors in Collaboration

In order to be able to create a framework of collaboration LANG ET AL. (2016) performed an extensive literature research for factors which are influenced when companies collaborate with the ten different partners shown in the column model above. The factors were validated through expert interviews in various meetings with industrial partners.

When companies open up and start to collaborate on a higher level, there are positive and negative characteristics to those factors. The negative characteristics were defined as risks and the positive as chances.

- Quality of relevant knowledge inside the company
- Quantity of relevant knowledge inside the company
- Use of competencies of one´s own company and competencies of one´s partner
- Velocity of the product development process
- Adaptability of the product development process
- Performance of the product development process
- User experience – product meets (qualitative) requirements
- Sales volume of the product
- Project costs
- Image/brand value of the company
- Market position of the company
- Legal situation

(LANG ET AL. 2016)

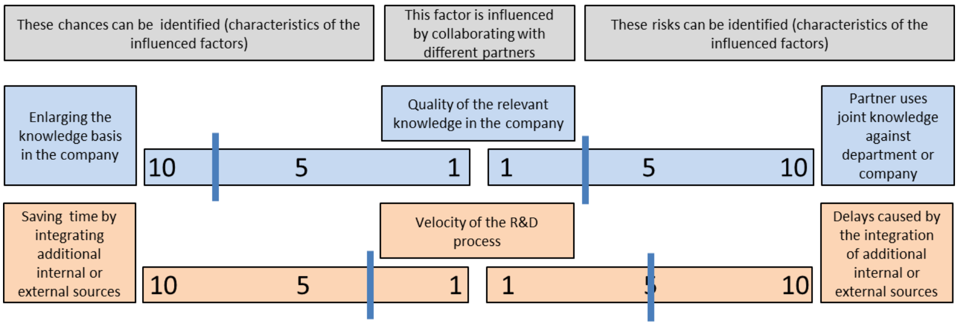

Figure 3 – Two of the twelve influenced factors and their characteristics

In the example shown in figure 6, an automotive supplier sees large chances (8) with regard to the quality of the relevant knowledge in the company but also risks (3), but which are much smaller than the chances, when asked about a project in product development. Looking at the second influenced factor – the velocity of the process – they see a small chance (3) and a slightly bigger risk (5). When having all 12 factors rated by the managers in the companies, the pattern illustrated in figure 7 could be developed.

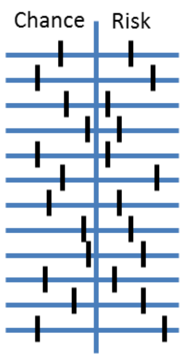

Figure 4 – Typical pattern of chances and risks of the twelve influenced factors.

Phases in the product development process

As collaboration patterns change with regard to the process-stage of the product development process, the process itself was analysed in a series of interviews. Two major phases of the product development process relevant for the way collaboration was performed were identified:

- Phase 1 – process steps taken prior to fully understanding the customer's needs
- Phase 2 – process steps taken in the development of the technical solution

(LANG ET AL. 2016)

This simplification of the complex product development process made it possible to perform a detailed analysis of the collaboration patterns which otherwise would have been impossible due to the amount of data gathered.

Measuring risks and chances

Using the categories mentioned above, questionnaires were created by LANG ET AL. (2016) containing fields for each combination of

- Partner
- Process phase
- Influenced factors

For each of these combinations companies were asked to estimate the chances, risks, benefits (realized chances) and damages (realized risks) they were able to identify in a running or completed project, each on a scale from 0 (low chances or risks) to 10 (high chances or risks). This led to matrices of values for risks and chances for each process phase and company like the one shown in figure 5 (LANG ET AL. 2016).

Form of collaboration/ column of the column model/ cooperation between	Different departments		Different business units		Different entities in the same group of companies		Supplier		Direct customer	
Real openness (RO)	75%		75%		25%		50%		100%	
	Chances	Risks	Chances	Risks	Chances	Risks	Chances	Risks	Chances	Risks
Quality of the knowledge	5	0	8	3	3	5	8	8	10	10
Quantity of the knowledge	5	3	8	3	3	3	5	5	8	8
Benefit of the internal knowledge	8	3	8	5	3	0	8	3	8	8
Velocity of the R&D process	8	0	3	5	0	3	10	8	8	10
Adaptation of the R&D process	10	0	5	5	0	5	8	5	10	8
Performance of the R&D process	8	3	3	8	8	5	8	8	10	8
User Experience	5	3	3	3	0	0	5	3	8	3
Sales volume of a possible product	3	0	0	0	3	0	0	0	8	3
Overall project cost	8	8	5	8	0	5	3	5	3	8
Image of the company	8	0	5	0	5	5	5	8	8	8
Market position of the company	8	2	0	0	2	0	3	3	2	3
Legal issues	5	0	2	2	0	0	3	8	2	10

Figure 5 – Exemplary table of chances/benefits, risks/damages when collaboration with five different groups, LANG ET AL. 2016

Virtual openness as value for the desired condition of collaborative openness

To make it possible to compare this data on chances, benefits, risks and damages with the raised data on the real openness in collaboration with the partners mentioned above, the term of virtual openness was introduced. As explained earlier the Real Openness (RO) was measured directly in the interviews. The values for the risks and chances, which were also measured in the interviews directly, were used to calculate a virtual openness. If the values of the virtual openness would differ from the real openness, measures could be deduced and by implementing those measures, changes within the companies would occur and an ideal openness would arise.

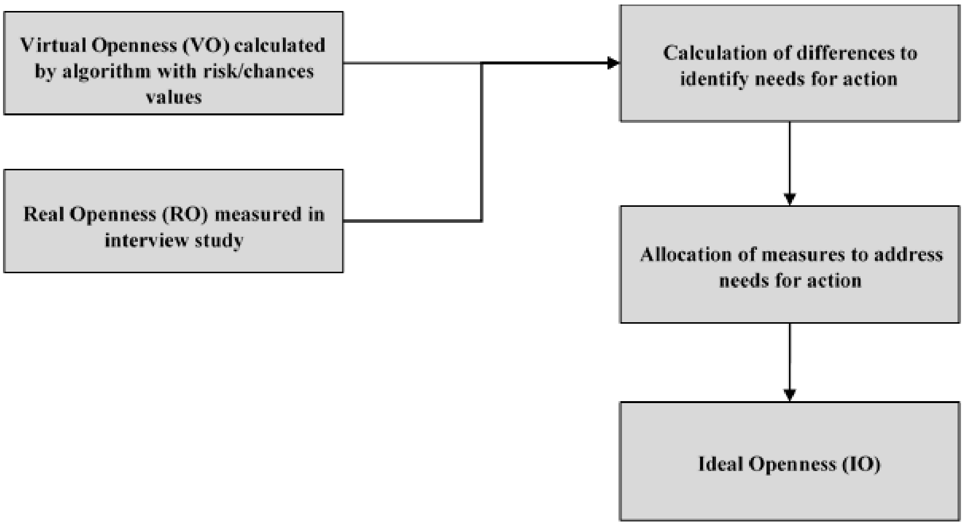

Figure 6 – Qualitative process for allocation of measures for reaching Ideal Openness (IO)

Calculation of virtual openness

Adding up risks and chances in order to calculate the value of the virtual openness seemed to be very simple and by looking closer at the construct, the negative aspects could easily be seen. When risks and chances are equally large, both have values of 10 and -10, and it adds to 0. If risks and chances are equally low, it also adds to 0. Collecting more of those obvious deficits of summation methodology, a variety of optimisation rules was defined. In order to determine the quality of the optimised algorithm, values for the virtual openness with the simple and the more complex algorithm were calculated and the results were demonstrated to companies and asked for judgment of which algorithm would produce the best results.

The first algorithm used included a simple addition of the values of chances/benefits and risks/damages of one column of collaboration in one process phase counting chances/benefits as positive and risks/damages as negative values. The resulting accumulated sums were then normalized to a percentage scale to make them comparable to the values of real openness mentioned above.

The second more complex algorithm was modelled on the basis of the first one. Additionally, the following optimisation rules were defined:

- In cases in which the values for all risks in a column are zero and the values for all chances in a column are zero, the Virtual Openness (VO) is defined also as zero.
- In cases where the sum of the risks outweighs the sum of the chances, the Virtual Openness (VO) was defined to be zero to emphasise a strong need for optimization.
- In cases in which positive and negative aspects have equal absolute values, it is defined that the values for the Virtual Openness (VO) are proportional to the chances (with a max. value of 50%) instead of being zero. This is due to the fact

that higher chances are paid for with equally high risks but higher chances also make the overall possible outcome for the company more attractive.

- In cases in which the values of the risk were equal to 0, the Virtual Openness (VO) is strictly proportional to the value of the chance as no negative implications are to be expected. For the maximum value of the chances, the Virtual Openness (VO) hits the maximum value of 100%.
- In cases in which the value for the risks in a column is half the value of the chances or bigger, the Virtual Openness (VO) grows under-proportionally to the value of the chances. If the value for the risk in a column is below half the value of the chances or smaller, the Virtual Openness (VO) grows over-proportionally to the value of the chances.

Both algorithms, the simple summation algorithm (SA) and the advanced algorithm (AA), which is based on the optimization rules, are both visualised by their three-dimensional graphs as functions of the values for chances and risks accumulated for one column of collaboration. This is shown in Figure 7 and Figure 8.

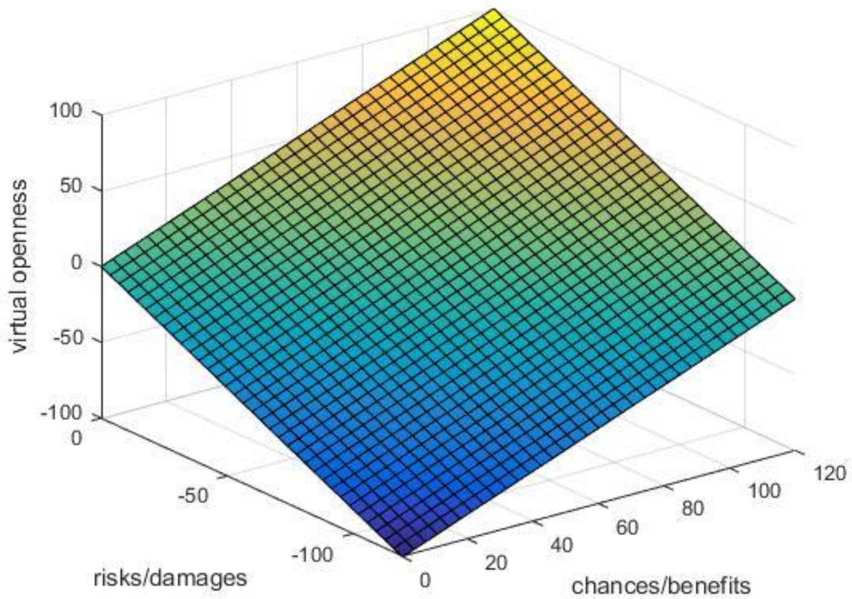

Figure 7 – Visualization of the simple algorithm (SA) for the calculation of the Virtual Openness (VO)

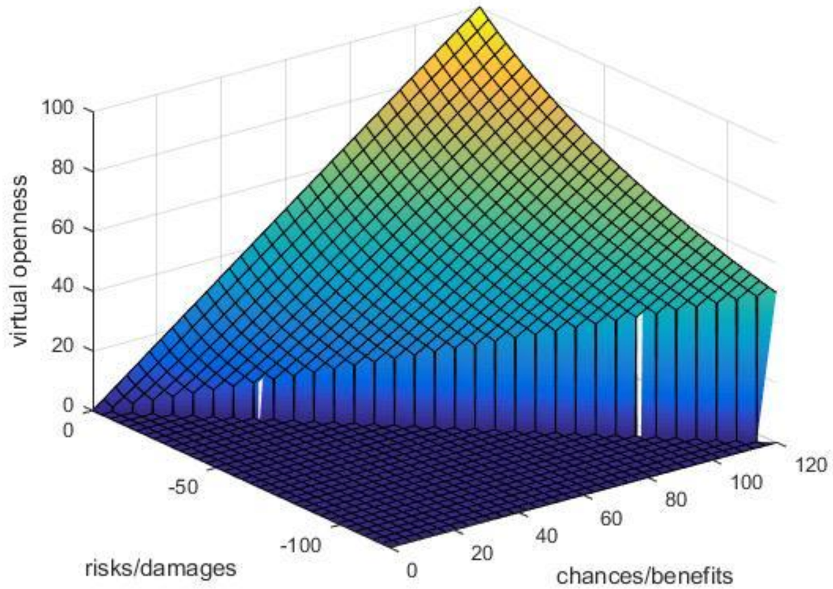

Figure 8 – Visualization of the advanced algorithm (AA) for the calculation of the Virtual Openness (VO)

Relative importance of needs for action

In order to rate the quality of the two algorithms, the importance of the influenced factors were calculated by using the two different algorithms. It generated two different sets of recommendations, which then were discussed with the companies, where in a prior interview risks and changes were acquired. Managers, using different criteria, rated the set of the selected influenced factors and by doing so, they rated the quality of the algorithms.

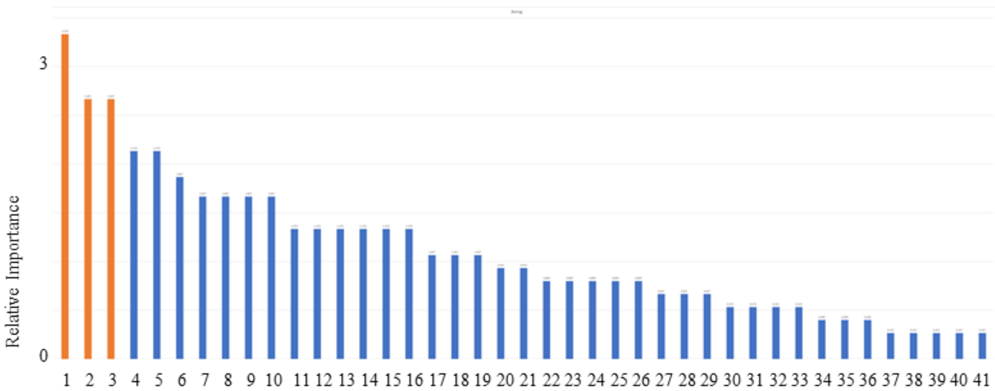

Figure 9 – The rated influenced factors for one process step

In order to sort the influenced factors according to their importance, the Relative Importance (RI) of the factors were calculated.
The Relative Importance (RI) includes two aspects; those two aspects are multiplied to calculate the Relative Importance (RI).

- The first aspect is to determine the partial importance of need for optimization of a specific column in proportion to the overall need for optimization. For this, the absolute values of difference between Real Openness (RO) and Virtual Openness (VO) for the considered column of collaboration (containing the influenced factor, marked by i) are set in proportion to the sum of these differences of all 10 columns (1 to 10).
- The second aspect is to determine the potential for optimization (be it realization of chances or avoidance of risks) of each factor. For this the single values of the risks (R) are subtracted from the related single values of the chances (C) for each influenced factor (marked by j).

$$RI_f = \frac{|RO_p - VO_p|}{\sum_1^{10} |RO_i - VO_i|} * (C_f - R_f)$$

RI – Relative Importance
RO – Real Openness
VO – Virtual Openness
C – Value of Chances
R – Value of Risks
i – Control variable index for number of collaboration column and collaboration type respectively for summation
f – Variable index for influenced factor
p – Variable index for the collaboration type for which the values of Openness (RO, VO) are calculated

Visualising each set of influenced factors in a diagram with decreasing importance made it possible to cut out a reasonable set of influenced factors by cutting at an over-proportional edge (Figure 9).

Allocating recommended measures

Having identified two sets of top prioritised influenced factors, recommendations for each set of factor were developed. This was done by using the positive and negative characteristics of the influenced factors and a catalogue of possible measures to optimise collaboration in R&D collected by KREMER ET AL. (2016).

As the two different algorithms were creating two different sets of prioritised influenced factors, recommendations were defined for each set of factors. As mentioned above, looking at sets of influenced factors, managers had to decide, which algorithms would produce the better results in validation workshops with companies. Afterwards they were asked for their own ideas of recommendations for each prioritised influenced factor and finally the set of recommendations which belongs to the algorithm was selected, discussed and the ones with a zero-fit to the company situation were dismissed.

Interview methodology

It was made sure, that interview partners were the same ones as in the first series of interviews for the collection of the initial data. As introduced above the interviews had two tasks, the validation of the algorithms for calculation of the Virtual Openness, the validation of the recommendations and the generation of additional – company specific – recommendations.

1. The interviewee was presented the top prioritised influenced factors, resulting from the application of both algorithms.
2. The interviewee was asked to rate the influenced factors of each algorithm using the following criteria:
   - Practicability: “How good do these factors represent your view of the problems in collaboration scenarios in your company?”
   - Possible velocity of resolution: “How fast could measures be taken to address the factors?”
   - Effort and/or costs: “How expensive (monetarily and non-monetarily) would it be to address the problems?”
   - Use of resolution: “To what degree would it help your company if the challenge behind the factor will be solved?”
   - Overall cost/value ratio: "How large would the value be if recommendations on the selected factors will be taken in ratio to their costs?”
3. The results of both algorithms were compared and the favoured set of factors was selected.
4. The interviewee was presented the detailed descriptions of the factors identified, which were generated by the selected algorithm only, and asked to find recommendations to meet the tasks implemented in the factors.
5. After the interviewee had finished the generation of recommendations, the allocated suggestions of recommendations generated by the interviewer were presented and the interviewee was asked to state whether these were suitable. Recommendations not suitable and without fit to the companies situations were dismissed.

5 Findings

Choice of Algorithm

Asking the interview partners about their preference regarding the algorithm by letting them choose between the two sets of suggested influenced factors, the managers selected in all process steps and in all performed interviews the advanced algorithm (AA). In the following the results of one company are visualised as an example. Due to non-disclosure agreements not all companies have agreed to the publication of their results.

Table 1 - Evaluation of the results regarding the simple algorithm (SA) and the advanced algorithm (AA) in process phase 1, average values rounded to one decimal figure.

Category	*Simple algorithm (model 1)*	*Advanced algorithm (model 2)*
Practicability	5.0	6.3
Possible velocity of resolution	6.7	5.0
Effort and/or costs	7.3	8.3
Use of resolution	7.1	5.0
Overall cost/use ratio	7.1	6.7
Overall average	6.6	6.3

Table 2 - Evaluation of the results regarding the simple algorithm (SA) and the advanced algorithm (AA) in process phase 2, average values rounded to one decimal figure.

Category	*Simple algorithm (model 1)*	*Advanced algorithm (model 2)*
Practicability	4.6	7.5
Possible velocity of resolution	4.6	7.9
Effort and/or costs	3.8	7.9
Use of resolution	3.8	7.9
Overall cost/use ratio	3.8	7.9
Overall average	4.1	7.8

In process phase 1 i.e., before the company has entirely understood the customers' needs, both algorithms perform nearly equally well. Even though the simple algorithm performed slightly better, the manager selected the influenced factors generated by the advanced algorithm and by doing so selected the advance algorithm.

In phase 2, which marks the development of the technical solution on the basis of the customers' needs, model 2 performs significantly better.

Measures recommended by interviewees and suggestions based on literature

The recommendations suggested by interview partners as well as those derived from the literature were clustered according to the process phase, collaboration partner, affected factor and the form of the recommendation: chance realization or risk avoidance.

Process Phase 1 – Understanding the customers' problems and requirements

Collaboration partner: Customer
Influenced factor: User Experience
Description of the influenced factor: Realization of chances through the potential of improving user experience and fit of product solution to the customers' needs
Suggested recommendations:

- Visits to R&D engineers at the customers' in order to increase trust between customer and company
- Increasing opportunities for communication through regularly scheduled appointments among R&D engineers
- Relocating of one´s own R&D engineers to the customers', at least for 2/3 of the project
- Workshops with customers during the development phase, in order to influence and direct the customer in a way beneficial for one´s own company.
- Increasing focus on the communication with customers to increase overall understanding of the customers' needs and use cases

Collaboration partner: Customer
Influenced factor: Legal issues
Description of influenced factor: Avoidance of risk in the legal situation with customers caused by uncertainties in the IP situation and liability
Suggested recommendations:

- Clarification of legal situation and development of contracts well in advance before project start
- Signing of NDAs with customers before any contextual discussions have begun

Collaboration partner: Supplier
Influenced factor: Velocity of the development process
Description of influenced factor: Avoidance of risks when integrating suppliers through delay in the collaborative development process
Suggested recommendations:

- Development of more intense relationships with suppliers
- More frequent contacts and communication with the supplier, closer integration of the supplier in the R&D process
- Implementing APQP methodologies

Collaboration partner: Supplier
Influenced factor: User Experience
Description of influenced factor: Risk avoidance in the area of user experience due to missing knowledge of UX requirements in the collaboration with the supplier
Suggested recommendations:

- Joint workshops with customers and suppliers
- Integration of the supplier as early as possible
- Direct contact to customers and their needs for all employees involved, also for employees of the suppliers

Process Phase 2 – Development of the technical solution

Collaboration partner: Supplier
Influenced factor: Cost of project
Description of influenced factor: Avoidance of risks caused by higher project costs which derive from delays in the integration of partners, coordination efforts and delays in processes
Suggested recommendations:

- Closer collaboration with suppliers by organizing more frequent/ regular review meetings
- Creation of more interdisciplinary teams
- Development of a purchasing process, which focuses on a better definition of the purchasing order
- Employees of the company need to be involved in every project, even when mainly executed by supplier and engineering services
- Optimisation of the project controlling system

Collaboration Partner: Neighbour departments
Influenced factor: Quantity and quality of knowledge
Description of influenced factor: Realization of chances through transfer of knowledge between departments
Suggested recommendations:

- Exchange of employees between departments (e.g. between central R&D department and project teams in both directions)
- Introduction and widespread communication of knowledge management processes and tools

Collaboration Partner: Neighbour departments
Influenced factor: Usage of competencies
Description of influenced factor: Realization of chances in the use of competencies of the departments involved
Suggested recommendations:

- Creation of competency profiles of all R&D engineers and implementation of competence management tools and processes
- Reduction of the habit to staff projects by using personal contacts only
- Identification of "hidden" competencies of the R&D engineers in order to include those competencies in the process of project staffing
- Development of a process to create project histories and 180° feedback of all team members automatically

6 Summary

Contribution

Following the demand for a more holistic view on opening processes in R&D environments, this paper develops a method to generate recommendations as a basis for strategy development, which not only focuses on the chances but includes the risks which evolve from collaboration with others as well. This supports the argumentation that openness cannot only be seen as solution to the challenges of modern businesses but has to be handled with caution and the specific openness of companies has to be designed to fit the company's needs. LAURSEN'S & SALTER'S (2006) model of an optimal degree of openness, the maximum of an inverted U shape graph is a first attempt to define the point of optimal openness.

The method explained here goes beyond the more theoretical maximum of the inverted U shape by identifying risks and chances using a quantitative and empirically based method. This aligns with the demand of various companies for practically-orientated and more resilient ways of decision-making in the process of designing a more open organisation.

The developed methodologies, including the algorithms to calculate the Virtual Openness (VO) and the generation process for the recommendations were validated in various interviews with companies.

Despite the positive results shown, additional research on this is needed. Clearly, the small number of validation interviews conducted is not sufficient to get scientific evidence for the correctness of the developed approach. Therefore, more workshops must be performed in order to further validate and specify the findings and create a broader catalogue of measures for collaboration.

Practical Implications

Companies have understood the need for a more collaborative approach in R&D. But how openly should a company collaborate with the different players?
This paper shows a methodology, which helps to generate recommendations what risks to avoid and what chances to take.

Based upon industry specific situations in companies and the chances and risks seen by the managers, the methodology develops a set of recommendations on which the manager can base their strategic decisions on how to move forward transforming their organisation from close to open. Implementing the recommendations will reduce insecurities when making decisions in the process of opening up the R&D department.

Each interview with companies produces an additional set of recommendations, which are linked to the identified challenges the companies are facing. Over time a matrix of industry specific challenges and recommendations will develop and contain general solutions for companies looking for advice on the pathway to more collaboration.

The matrix could be integrated in a database and enriched with company and industry specific data, like company size, sales volume, type industry, type business model or age of the company. By doing so, a user would have the possibility to perform benchmarks or statistical analyses and, based on their findings, generate company specific strategies to transform the R&D process into an Open Organization.

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