Strategic Technological Sourcing Decisions in the Context of Timing and Market Strategies: An Empirical Analysis

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In times of changing business models and international competition, there is an inherent need for companies to foster and develop mechanisms to absorb new technologies for innovative products and processes effectively. Such considerations lead to the strategic make-or-buy decision which was the subject of our research. This quantitative explanatory study in the German industry shows in particular that companies base their decision for internal or external sourcing on multiple weighted criteria with scoring models and, even more common, with portfolio matrices. These results are in common with recent research, however, other results are surprising, e.g. just a small minority of companies involve people from controlling and legal departments in these decision processes. The paper also reveals differences between companies with different timing and competitive strategies, which are in line with the proposed characteristics of these strategic focuses in literature. Implications for theory and practice are given to foster future research in this area.

Keywords: Sourcing decision; technology management; innovation strategy; make-or-buy.

1. Introduction

Research and development (R&D) activities are essential for technology-based companies. Therefore, it might be surprising — from the perspective of management theory — that, in practice, R&D activities are increasingly outsourced. Against the background of recent literature streams on open innovation, which has dominated innovation management literature for the last five years, this might be an explanation. In any case, this goes along with little technological knowledge of a company, high transaction costs and a variety of partnership risks [Narula (2001)]; knowledge as such can be sourced externally [Gomes and Kruglianskas (2009)]. Nevertheless, in times of global competition, the trend toward utilizing external R&D services continues [Niwa (1999)]. Moreover, the lack of qualified employees, especially engineers, and increasing cost competition have contributed to this trend of external R&D, at least in Germany in recent years [BMBF (2003)]. And research confirms that the intensive integration of suppliers in the value creation process positively influences the success of the company, particularly in highly competitive industries [Wingert (1997)].
Technology sourcing is in general considered to be a main task of technology management, which can be solved by internal or external R&D [Brockhoff (1992)]. As a company cannot develop all technologies by itself, other options must be taken into consideration. Even early work showed that external sourcing, compared to internal sourcing, can e.g. bear lower inherent risks [Gold (1971)], save time and therefore reduce the time to market entry [Baranson (1978)], or help to upgrade in-house R&D capabilities [Killing (1977)]. However, external R&D is not superior in general. Especially companies that have no internal R&D activities tend to be less successful than others [BMBF (2003)]. On the other hand, a solely internal perspective can lead to be “blind” to the shortcomings of the company. Therefore, it is vital to have the “right” balance between internal and external technology sources, because a multifaceted approach, which means using several modes of acquisition, enhances the technological responsiveness of a company [Nichols-Nixon and Woo (2003)], which is an important issue in global competition [Bettis and Hitt (1995)]. Furthermore, the appropriate acquisition decision can lead to operational and strategic benefits [Daim and Kocaoglu (2008)]. Therefore, it is important to find the optimal combination of internal and external technology sources [Gerpott (1999)].

Finally, regarding the “right” make-or-buy decision, there is a plethora of criteria that have to be considered. So, the final assessment of the different alternatives of external acquisitions is a strategic decision which needs to be made, communicated and supported by the top management [Brem (2007)].

Such decisions regarding the external acquisition of technological knowledge have to be planned and coordinated companywide and in line with corporate technology and strategy planning processes [Cosner et al. (2007)]. If this does not happen, there is a high risk of internal opposition from the beginning, which might result in a not-invented-here syndrome. In the context of technology strategy, this particularly means the critical decision about the internal or external acquisition of (new) technologies [Ford (1988)]. This essential decision and its process are the subject of our research in this paper.

Therefore, we provide a detailed theoretical framework based on a broad literature review to research the linkage between competitive strategy, technological market entry strategy [Porter (1985)], and the technology acquisition decision. For the competitive strategy, we especially address the advantage being either differentiation or cost leadership. Regarding market entry, the options of being a pioneer or a follower are distinguished. Each of these different strategies are linked to the use of external technology sources, the organization of the decision process, and the methodical decision support. The market entry strategy and the competitive strategy are analyzed separately. Finally, we will discuss our findings with implications for theory and practice.

2. Theoretical Background

2.1. Technology and strategy

To balance internal and external technologies and to make a decision on a specific technology is influenced by the technology strategy which shall be embedded in the
company’s corporate strategy [Ford (1988)]. Obviously, the strategic fit between technology and strategy on company level is very important [Zahra and Covin (1993)]. On the one hand, the strategic alternatives of a company depend on its technological resources as these determine a company’s strategic flexibility [Itami and Numagami (1992)]. On the other hand, technology-related decisions depend on a company’s (long-term) business strategy [Zahra and Covin (1993)].

Following Porter [1985], the technology strategy has to address three main issues:

- what technologies should be developed,
- the role of technology licensing, which can be seen as external sourcing, and
- whether to seek technological leadership in these technologies.

Therefore, technological leadership or followership can result in a competitive advantage, either low-cost or differentiation. These advantages can be used either for a broad or narrow competitive scope representing Porter’s generic strategies. This relationship between competitive advantage and technological strategy is illustrated in Fig. 1.

Thus, the competitive strategy is closely connected to the market timing strategy, which can generally be a first mover (pioneer) or a later entrant (fast or late follower) strategy [Voigt et al. (2006)]. First movers might be able to implement a differentiation advantage as they are the first on the market. Furthermore, they can realize cost advantages as they are also the first who can benefit from learning curve effects. However, a follower may also be able to achieve these advantages because of lower imitation costs, free-rider effects, scope economies, or learning from the pioneer’s mistakes [Kerin et al. (1992)]. Time-to-market can therefore be seen as a key to competitive advantage and has important implications for R&D [Voigt (1998)].

<table>
<thead>
<tr>
<th>Cost advantage</th>
<th>Technological leadership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Pioneer the lowest-cost product design</td>
</tr>
<tr>
<td></td>
<td>- Be the first firm down the learning curve</td>
</tr>
<tr>
<td></td>
<td>- Create low-cost ways of performing value activities</td>
</tr>
<tr>
<td>Differentiation</td>
<td>- Pioneer a unique product that increases buyer value</td>
</tr>
<tr>
<td></td>
<td>- Innovate in other activities to increase buyer value</td>
</tr>
<tr>
<td>Technological</td>
<td>- Lower the cost of the product or value activities by learning from the leader’s experience</td>
</tr>
<tr>
<td>followership</td>
<td>- Avoid R&amp;D costs through imitation</td>
</tr>
<tr>
<td></td>
<td>- Adapt the product or delivery system more closely to buyer needs by learning from the leader’s experience</td>
</tr>
</tbody>
</table>

Fig. 1. Technological strategy and competitive advantage [Porter (1985), p. 181].
fit of technological choices and the company strategy and policy was also examined in empirical studies. Zahra and Covin [1993] researched the link between business strategy, technology policy and company performance. Their study focuses on different business strategies. Their findings indicate that technology policy choices vary across companies with different business strategies. Parker [2000] shows that the fit of technology policy and business strategy can be a predictor for organizational performance. Their findings stress the importance of a strategic fit between technological decisions and the underlying business strategy. Moreover, these empirical findings confirm the importance of the “right” decision regarding external or internal technology acquisition as an essential component of the company’s technology strategy with implications to its competitive strategy [Zahra et al. (1994)]. Hence, the final sourcing decision has to be made considering several distinct sourcing alternatives, which will be introduced in the following.

2.2. Generic alternatives for technology sourcing

First of all, we give a short overview of technology sourcing alternatives considered in this paper. The most common mode of technology management is the internal R&D management. Internal development contributes to build up knowledge, which is especially important for core technologies, which are part of the company’s strategic orientation and, consequently, its success [Gerhard et al. (2008)]. Especially if the company intends to be a technology leader in a certain area, internal expertise is crucial. Another reason refers to the development process itself as development activities can be directly controlled and the company does not depend on results from others, which enhances flexibility. This also includes the question of knowledge protection and utilization [Brodbeck (1999)]. The increasing problem of product piracy underlines these arguments [Voigt et al. (2008)]. In general, it can be stated that the earlier the technology life cycle position and the less urgent the acquisition is, the more a company should consider developing a technology in-house. However, this also includes higher commitment and investment [Ford (1988)].

External R&D activities can be distinguished in terms of whether the technology is already available on the market or not. In general, the respective technology is not yet available on the market at the point of the assignment [Schneider and Zieringer (1991)]. Contract research and development are typical forms of external R&D in this case. Possible contract partners are often science-based universities and research facilities as well as publicly-owned engineering service companies. Depending on the type of technological knowledge that is sought-after (fundamental versus applied research), companies must decide on the right partner. Reasons for contract R&D can be a lack of resources, technological lead of the competitor, lack of time, or less development costs in comparison to internal development [Hauschildt and Salomo (2011)]. Furthermore, the inherent development risk can be reduced [Brodbeck (1999)]. Hence, external development can contribute to make R&D more flexible with lower fixed costs as resources can be easily expanded or reduced without redeployment. A major disadvantage of contract R&D is the fact that the accumulated knowledge occurring during the development process is not available. In addition,
knowledge protection is more difficult to control in comparison to internal R&D [Kern and Schroeder (1977)].

Furthermore, technologies can be purchased on the market if the technological knowledge already exists. Of course, the potential seller has to be willing to vend his knowledge. Possibilities of external purchasing are the alternatives of licensing, patent or technology acquisition, component delivery, and company acquisition [Brodbeck (1999)]. If a license is acquired, the technological knowledge still belongs to the seller, the purchaser only has the right to utilize the technology in certain ways. Technological knowledge can be protected by patent or other rights [Mittag (1985)]. For the purchaser, an exclusive license is of special interest as this makes him the only one to utilize the technological knowledge [Wolfrum (1994)]. The inherent risk of technology development can be dramatically lowered by purchasing a license as the result of knowledge already exists and is ideally market-ready [Schneider and Zieringer (1991)]. However, it is not suitable to gain sustainable competitive advantages in the long term [Wolfrum (1994)].

In contrast to licensing, the ownership of the technology can be assigned by technology purchasing. Therefore, the purchaser acquires the full utilization rights. The transfer can be conducted materially (e.g. patent) or immaterially (e.g. knowledge of employees) [Michel (1990)]. Furthermore, the purchasing of patents enables the company to be the first to market having a protected basis [Perillieux (1987)]. A common problem is the correct implementation of the transferred knowledge [Lichtenthaler and Ernst (2006); Wolfrum (1994)].

Another alternative is to buy a whole company — the most complex but also holistic version because in this case, not only patents and knowledge, but also employees and their accumulated knowledge are being purchased. Acquiring small specialized companies because of their employees, which are familiar with a certain technology, is called educational acquisition. For this form of acquisition, it is important to make sure that the specialists do not leave the company after the acquisition [Roberts and Berry (1985)]. A company acquisition can be an alternative if there is little competence in a certain technological field and a build-up of these competences would be too extensive and expensive. It is also an option if the concerning company is not willing to license its technology. In addition to that, it is a good possibility to gain full access to a certain technology [Wolfrum (1994)].

Finally, a company can gain access to a certain technology by purchasing components that already contain the technology from a supplier. The control over utilization is weak and exclusive distribution is not guaranteed. However, the technology is available fast and market-ready [Hermes (1995)].

Brodbeck [1999] developed an approach that distinguishes between the source of new technologies and the differences between external procurement and external sourcing, respectively — based on the question of whether the technology already exists within the company or not. Based on that, he classifies the introduced technology acquisition alternatives in a continuum between external procurement and external R&D (see Fig. 2).

Besides the two extreme forms of internal R&D and external procurement, there are diverse hybrid forms, depending on the question as to whether the technology
already exists in the company. Such hybrid forms require specialized and capable R&D departments in both companies. The willingness to cooperate and mutual trust are important for an efficient coordination and communication process, which is essential for the cooperation success [Wolfrum (1994)]. Hence, there is seldom one single solution like “one size fits all” — on the contrary, every case is more or less individual, depending on the level of integration [Brem (2007)]. Independently from the question of whether the cooperation form is internal, external or hybrid, it is a critical success factor that a company has the right mode for screening methods. Recently, technology and innovation radars have been discussed to find out whether such tools can be used for technology scouting [Golovatchev et al. (2010)].

The joint research alliance can be seen as a development network where each partner separately develops a defined assignment on his own. The development process is coordinated across all companies concerned and the results are finally brought together. Hence, development projects that would be too complex for one company can be realized without restructuring [Machunsky (1985)]. In contrast, research in joint ventures is institutionalized by forming a new venture, which is funded by the companies involved. Normally, each company sends its specialized employees and other resources to this joint venture for the limited time of existence. The ventures are only launched for R&D purposes [Hauschildt and Salomo (2011); Machunsky (1985)].

A study conducted by Daim and Kocaoglu [2008] shows that companies see the acquisition channels of in-house development, vendors, and suppliers as most important. The findings also indicate that different channels are used at the same time. Hermes [1995] addressed this question in an empirical study as well. The results show that companies tend to use an average of 2.5 sources simultaneously; most important are in-house R&D, suppliers, contract research, and licensing.

Fig. 2. Alternatives for the acquisition of technologies, following Brodbeck [1999, p. 102], translated by the authors from German.
However, the question remains as to which and how functional departments are involved in technology sourcing decisions. Surprisingly, this question has not been previously addressed in literature on technology sourcing decisions [Lê and Gastl (2004); Brem (2007)].

2.3. Decision process and methodical support

Another important issue refers to how to decide about developing internally or externally, and if externally, what acquisition mode should be chosen (see Fig. 3). This addresses the organization, process and methodical support [Clarke et al. (1995)]. It can become problematic when companies fail in the management of this complex decision making [Chatterji (1996)]. Therefore, Durrani et al. [1998] outline the importance of this decision process.

There are several approaches in literature to model the decision process of technology sourcing [e.g. Chatterji (1996); Baines (2004); Howells et al. (2004); Daim and Kocaoglu (2008)]. They have in common that they distinguish several steps from the identification of a need or gap to the implementation of the technology. The step of specific decision making about the sourcing of a technology is of special interest for our work. Brodbeck’s empirical findings for this specific task indicate that the decision itself is and should be made by the head of corporate management [Brodbeck (1999)]. This is easy to understand as top-management decisions normally implicate top-management support [Brem (2007)].

Regarding the make-or-buy decision itself, there are three basic categories of methodical approaches to support the decision making to be distinguished: univariate, bivariate and multivariate models, depending on the different assessment criteria used.

The transaction cost theory is the basis for univariate approaches, which explains the expenditure of certain alternatives on the basis of the transaction costs [Coase (1937); Williamson (1973)]. From Williamson’s formulations, e.g. Schneider and Zieringer [1991] developed a univariate tableau to identify a dominant strategy taking into consideration the transaction costs as a central decision factor. This practical approach enables specific advice on the basis of evaluating each factor. In addition, the factors can be rated. The approach does not integrate information about the overall costs, although this would be necessary as different companies have different technological starting points. Overall, the approach is operational, but also has several deficiencies [Schneider and Zieringer (1991); Hermes (1995)]. Univariate models only consider one variable to assess the benefit of an alternative, which has to be seen critical as regards a realistic judgment. Furthermore, they only allow making a statement about internal or external procurement but do not consider the different alternatives within external procurement [Hermes (1995)]. Hence, univariate approaches based on transaction cost theory have only low practical relevance for the final decision making. Apart from that, they can serve as a structural filter, which is also proposed by Schneider and Zieringer [1991].

Bivariate approaches consider two variables for the make-or-buy decision. Often, these models use a matrix or portfolio design to illustrate their decision
structure. Therefore, we would like to introduce the familiarity matrix of Roberts and Berry [1985], which was developed in a new business development and market entry strategies context (illustrated in Fig. 4). We introduce this model for make-or-buy decisions as market and technology-oriented factors are conceptually integrated. The dimensions of the matrix are “technology or services embodied in the product” and “market factors”. On this basis, discrete strategies are proposed. The three categories are explained by the familiarity of the company with the specific technology and the market. “Base” technologies are already used by the company in other products. A base market is already occupied by the company. Within the “new familiar” category, the technology or market is new to the company, but there is already a connection to known markets or technologies. Finally, the last category describes markets or technologies that are very new to the company [Roberts and Berry (1985)]. The model allows discrete strategic proposals although these are not explicit, as some fields propose more than just one strategy. Hence, further situational information is needed to make a clear statement. This is in line with the trend to make use of external sources of

![Fig. 3. Alternatives of vertical integration [Brem (2007), p. 18].](image)

![Fig. 4. Familiarity-matrix and proposed strategies [Roberts and Berry (1985), p. 13].](image)
technological information [Gomes and Kruglianskas (2009)]. In addition to that, there is no possibility to directly rate the variables. In general, all approaches using a matrix or portfolio design to assess a technology acquisition decision can be seen as bivariate approaches [e.g. Krubasik (1989); Pearson (1990)]. Because of their matrix visualization, these models can be easily used to define the position of the company, which can then be communicated internally. The way of decision making can be easily explained and is therefore comprehensible. At least, these approaches can help to make a certain tendency statement. On the other hand, the complex process of the right decision making in situations is reduced to only two dimensions. The dimensions often rely on a possible subjective assessment like “good” or “bad”. In summary, bivariate matrix models can support the management by making the right decision or proposing tendencies, but they cannot give clear advice on the right situational decision.

Approaches considering more than two determinants to assess the advantageousness of alternatives are multivariate approaches [Gerpott (1999); Brockhoff (1992); Hermes (1995)]. Brockhoff for example combines approaches of different matrix models and the introduced transaction cost approach to a new form of assessment. He distinguishes in more detail than Roberts and Berry between the technology procurement and technology exploitation and considers three factors influencing the decision of technology procurement: market risk, time pressure, and point of market launch. The latter two are not independent as the point of market launch, which can be too early or too late, influences the time pressure [Brockhoff (1999)]. The multivariate approach also allows considering more criteria with different importance. Hermes [1995] for instance introduces a model which allows rating the importance of different criteria. His holistic model combines two approaches: the contingency approach and a multi-attributive value model. Multivariate approaches are clearly more complex and sophisticated than the uni- and bivariate models discussed above. Multivariate approaches are able to solve problems of uni- and bivariate models due to their flexibility. Nevertheless, the resulting complexity also bears risks as the models can be overloaded.

3. Methodology

The research process consisted of a four-step procedure: First, the identification and substantiation of the research objective were implemented. Second, a standardized online questionnaire was prepared. Mainly closed-ended questions were chosen [Schnell et al. (1995)]. The online questionnaire was designed in a manner to fulfill requirements such as clarity, clearness and simplicity of the questions [see Zikmund (1982); Schnell et al. (1995); Proctor (2000)]. Moreover, the questions asked were extracted from literature to the extent possible. Additional requirements concerning quality factors of online surveys, such as the avoidance of scrolling, etc. [Schonlau et al. (2002)], were fulfilled. The structure of the questions was based on a procedure suggested by Zikmund [1982] and Proctor [2000] asking general questions in the beginning and sensitive or rather difficult questions at the end of the questionnaire in order to ease the reply so that the respondent could get a general idea of the
questionnaire’s content [Churchill (1991)]. Moreover, each topic was treated separately, which supported this effect [Proctor (2000)].

The questionnaire itself consisted of four main parts. The first part gathered information about the strategy of the respondent’s company regarding the timing, competitive, and technology strategy. The timing strategy for technologies referred to the technological posture [Parker (2000); Zahra and Covin (1993)]. The respondents were asked whether their company tended to be the first on the market, a fast follower or a late follower. Regarding the business strategies, possible answers were cost leadership or differentiation with narrow and broad market focus. In the second part, the acquisition of technologies and the make-or-buy decision process were addressed. The third part dealt with the organization of the decision making and the methodical support. The respondents were asked which departments of the organization were involved in the decision process and how the decision making was organized. Furthermore, the respondents were asked to give information on who finally makes the decision in their companies. The fourth and final part gathered some general information about the respondent, the company and specific technology development aspects such as expenses for R&D and profit margin. The questionnaire is included in the Appendix.

4. Results and Discussion

4.1. Background findings

For our research, 354 potential persons were contacted who were Heads of R&D or Chief Technology Officers of industrial companies in Germany. These persons were identified through online databases and social networks. Within four months, 71 persons participated in the study, resulting in a response rate of about 20%. Forty-nine questionnaires thereof were usable giving important information on the companies’ strategy necessary for the conduction of the research. The majority of the companies had less than 1000 employees (56%). Company sales varied within a wide range; 72% of the companies achieved less than 500 million euros (see Fig. 5). 30% of the companies are from the automotive industry, 22% from the machine and plant industry, 17% from the electronic and communications industry, 13% from energy

![Fig. 5. Sales in € (n = 36) and employees (n = 39).](image-url)
and supply, 4% from the chemical industry and 3% from the medical industry. The remaining 11% are from different other industries.

Overall, 33 companies identified themselves as technological market pioneers, 15 as fast followers and one as a late follower. As there is only one company rated as a late follower, the strategies are only distinguished in pioneers and followers for the further analysis; fast and late followers are merged. Nine companies stated to have a competitive cost-leadership strategy with broad focus; four had the same strategy with narrow market focus. Seventeen companies use the differentiation strategy for broad market focus, 19 with narrow market focus. For the analysis, the strategies are distinguished referring to the competitive advantage, which is either differentiation or cost leadership, whereas broad and narrow market focuses were merged. The results are presented as a direct comparison between the corresponding strategies (pioneer to follower and differentiation to cost leadership).

### 4.2. Technology acquisition strategies

In a first step, the used alternatives of external technology acquisition were addressed. In a second step, the use of alternatives was analyzed in the context of the market entry and competitive strategy. As Fig. 6 shows, companies use external acquisition alternatives with lower inherent risk, such as component delivery or externally contracted R&D. Joint research is used less often compared to these alternatives. On the other hand, most of the alternatives were stated as being at least a considered alternative. Company acquisition and research in joint ventures were often not even

![Fig. 6. Alternatives of external technology acquisition used by companies, n = 39–42.](image-url)
seen as alternatives to be considered. Contract research with universities and patent purchasing were the alternatives with which companies gathered the most negative experiences. This is a surprising result as such collaborations are typically known as very successful [e.g. Devine et al. (1987); Bozeman (2000); O’Shea et al. (2005)]. Research in joint ventures and company acquisitions were the options which companies see as alternatives, but have concerns to avail themselves of. This is comprehensible as these activities are very cost- and risk-intensive. Overall, companies in our sample made positive experiences with the used alternatives.

Comparing the used alternatives (sum of positive and negative experiences) for the different market timing and competitive strategies, there are some notable differences (see Fig. 7). For the competition strategies, there are differences in the alternatives of company acquisition, joint research alliances, and patent or technology purchasing. Cost leaders more often stated to use company acquisition as a source for technologies whereas joint research alliances and patent or technology purchasing were more often used by companies with differentiation strategies. This fits the cost-driven strategy of cost leaders, as these forms of acquisition (except joint research) deliver results very fast by calculable costs. The risk of increasing costs during internal research due to delays or insufficient performance does not occur. Taking the not-invented-here syndrome into account, which these companies certainly have to deal with when using these acquisition channels, could be an interesting aspect in this context. Regarding the market entry strategy, especially the two

<table>
<thead>
<tr>
<th>Licensing</th>
<th>Component delivery</th>
<th>Patent or technology purchasing</th>
<th>Company acquisition</th>
<th>Joint research alliances</th>
<th>Research in joint ventures</th>
<th>Contract research by engineering company</th>
<th>Contract research by universities</th>
<th>R&amp;D by supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Differentiation</td>
<td>50%</td>
<td>94%</td>
<td>47%</td>
<td>47%</td>
<td>66%</td>
<td>35%</td>
<td>43%</td>
<td>63%</td>
</tr>
<tr>
<td>Cost leadership</td>
<td>64%</td>
<td>100%</td>
<td>27%</td>
<td>64%</td>
<td>45%</td>
<td>50%</td>
<td>33%</td>
<td>73%</td>
</tr>
<tr>
<td>Pioneer</td>
<td>52%</td>
<td>93%</td>
<td>35%</td>
<td>45%</td>
<td>64%</td>
<td>55%</td>
<td>54%</td>
<td>71%</td>
</tr>
<tr>
<td>Follower</td>
<td>57%</td>
<td>100%</td>
<td>53%</td>
<td>43%</td>
<td>53%</td>
<td>14%</td>
<td>15%</td>
<td>53%</td>
</tr>
</tbody>
</table>

Fig. 7. Acquisition modes for different strategies, n = 39–42.
alternatives of contract research by engineering companies and research in joint ventures were used more often by pioneers than followers. Also, the alternative of contract research was more often used by pioneers than followers. This could be an indication that pioneers more successfully focus their internal R&D activities on important technologies, outsourcing less important activities to external engineering suppliers. On the other hand, followers more often stated to use R&D by supplier and patent or technology purchasing. In all cases, component delivery is the favorite option. This alternative bears the lowest risk; hence, we can explain its high degree of acceptance. However, the question arises as to why pioneers are still able to realize their time advantage when both prefer that kind of strategy. First, it has to be taken into account that the different sourcing strategies can be combined and used at the same time. While a follower might rather rely on component delivery, a pioneer might source less technological knowledge via this sourcing channel in comparison. The study concept did not refer to the kind of technology being sourced by component delivery, which could be different for pioneers and followers. Another explanation could be that pioneers are able to keep their timing advantage even when they use component delivery by successfully integrating the supplier in their innovation process at the right time and in early stages, which is considered to be a success determinant [John (2010)]. Future studies could investigate these potential differences between pioneers and followers in more detail.

44% to 50% (depending on the strategy) of the companies in our sample have a centralized board, which is involved in the acquisition decision. In this form of organization, there is no difference between the diverse strategy types either. Companies that have several boards were further distinguished into independent and hierarchical boards. Hierarchical boards were more often used in companies with cost-leadership strategy. Differentiators more often stated to use several independent boards (see Fig. 8).

Fig. 8. Organization of technology acquisition decision, n = 39.
The respondents were also asked to state which departments participate in the decision process. First of all, it is notable that none of the companies consulted external experts for the decision making, neither technological nor methodical experts. The results about the competition strategy are presented in Fig. 9. There are notable differences regarding production and legal department. The production department participates more often at companies with cost-leadership strategy. Cost advantages are based on economies of scale and cheap manufacturing technologies, which can be seen as explanation of this difference. On the other side, companies with differentiation strategies more often stated to involve the legal and patent department in the decision making. This is quite understandable, as companies with differentiation strategies have a strong interest in protecting their unique technological know-how by property rights to gain a sustainable advantage.

For the market entry strategies, the results are presented in Fig. 10. Compared to the competitive strategy, the differences are more distinct, especially for the R&D department, the legal department, and the corporate management. This shows that pioneer companies also have a strong interest to legally protect their technological know-how, which helps to extend their timing advantage with regard to followers. The top management is also involved in these companies, which is an indication for the high importance of technology in general for these companies’ corporate strategies.

In general, regarding the whole sample, companies most often involve R&D, procurement, and production. Furthermore, the corporate management is often involved in the decision process. Controlling, legal, and marketing and distribution are less often mentioned to be involved in the process. As stated, external experts are not involved in general.
**Fig. 10.** Departments participating in the decision process for pioneers and followers, $n = 39–42$.  

<table>
<thead>
<tr>
<th>Department</th>
<th>Pioneer</th>
<th>Follower</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Procurement</td>
<td>79%</td>
<td>79%</td>
</tr>
<tr>
<td>Production</td>
<td>38%</td>
<td>38%</td>
</tr>
<tr>
<td>Marketing &amp; Distribution</td>
<td>21%</td>
<td>14%</td>
</tr>
<tr>
<td>Controlling</td>
<td>38%</td>
<td>43%</td>
</tr>
<tr>
<td>Legal/patent department</td>
<td>48%</td>
<td>57%</td>
</tr>
<tr>
<td>Corporate management</td>
<td>52%</td>
<td>50%</td>
</tr>
<tr>
<td>External experts</td>
<td>97%</td>
<td>64%</td>
</tr>
</tbody>
</table>

**Fig. 11.** Approaches used to support technology acquisition decision, $n = 45$.  

<table>
<thead>
<tr>
<th>Approach</th>
<th>Transaction costs</th>
<th>Scoring model</th>
<th>Portfolio/matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Differentiation</td>
<td>6%</td>
<td>31%</td>
<td>66%</td>
</tr>
<tr>
<td>Cost leadership</td>
<td>23%</td>
<td>46%</td>
<td>23%</td>
</tr>
<tr>
<td>Pioneer</td>
<td>17%</td>
<td>31%</td>
<td>66%</td>
</tr>
<tr>
<td>Follower</td>
<td>0%</td>
<td>44%</td>
<td>31%</td>
</tr>
</tbody>
</table>
Another part of the survey was the methodological approach for the decision making. A portfolio or matrix approach is most often used by companies with a differentiation or pioneer strategy (see Fig. 11). In comparison to pioneers, followers use scoring models more often, but the differences are not very distinct. The same is true for cost leadership compared to differentiation. The only notable difference between the diverse strategies in these cases is found with regard to the transaction cost approach and companies with a differentiation and cost-leadership strategy. Overall, the portfolio/matrix and scoring approaches are stated most often. Unfortunately, not enough respondents provided information on the criteria used for the specific approaches. Therefore, further analysis on this issue could not be conducted, but should be included in future research.

Finally, the decision making process was analyzed regarding the decision responsibility. Thirteen respondents stated that the final decision about the external acquisition of a technology is made by the senior corporate management in their companies. In six companies, the head of R&D decides on the acquisition, whereas only in two companies the head of the division is responsible for the final decision making. Eight respondents stated that a special committee decided on the acquisition, e.g. comprising heads of the company, R&D and the division.

5. Conclusion and Implications

First of all, our study confirms most of the recent findings in literature, which were illustrated in the theory part. For example, regarding external technology acquisition, our study confirms that suppliers are the most important source for technology acquisition. Against the background of the open innovation literature, this is a surprising result, as most publications on open innovation are focused on the integration of customers [Brem (2010)]. Second, the final decision is mostly made by the upper corporate management, which also confirms existing empirical findings. Our paper is the first of its kind offering insights into the alternatives of external technology acquisition chosen by companies. Surprisingly, commonly discussed approaches in the technology transfer literature — such as joint ventures or research alliances — do not have the importance assumed in this literature [e.g. Hagedoorn (1990)].

<table>
<thead>
<tr>
<th></th>
<th>Pioneers do/have more often</th>
<th>Followers do/have more often</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition channels</td>
<td>Contract research</td>
<td>R&amp;D by supplier</td>
</tr>
<tr>
<td></td>
<td>Research in joint ventures</td>
<td>Patent and technology purchasing</td>
</tr>
<tr>
<td>Organization</td>
<td>Several hierarchical boards</td>
<td>Several independent boards</td>
</tr>
<tr>
<td>Involvement of departments</td>
<td>R&amp;D</td>
<td>Corporate management</td>
</tr>
<tr>
<td></td>
<td>Corporate management</td>
<td>Legal/patent department</td>
</tr>
<tr>
<td></td>
<td>Differentiator do/have more often</td>
<td>Cost leaders do/have more often</td>
</tr>
<tr>
<td></td>
<td>Patent and technology purchasing</td>
<td>Joint ventures</td>
</tr>
<tr>
<td>Acquisition channels</td>
<td>Company acquisitions</td>
<td></td>
</tr>
<tr>
<td>Organization</td>
<td>Several independent boards</td>
<td>Several hierarchical boards</td>
</tr>
<tr>
<td>Involvement of departments</td>
<td>Legal/patent department</td>
<td>Production</td>
</tr>
</tbody>
</table>
Furthermore, our study revealed some notable differences between the researched strategy scopes referring to the technology acquisition decision (see Table 1). Companies with differentiation strategies tend to use more joint research and patent or technology purchasing. Also, they more often stated to have several independent boards for decision making. In addition, the legal department is more and more involved in the decision process. This is surprising as the legal department is normally not considered to be involved in such discussions. Companies with this strategy used a portfolio or matrix method to support their decision making. However, companies pursuing cost leadership as a strategy more often stated to use the scoring model as a methodical support. Compared to differentiation, they tend to involve the production department in the decision process and have more often several hierarchical boards. In our sample, they tend to use joint ventures as a sourcing alternative.

Pioneers within our study more often use the two alternatives of contract research companies and research in joint ventures. Furthermore, pioneers more often involve R&D, the legal or patent department and corporate management in the decision making than followers. Followers, on the other hand, more often stated to use R&D by supplier and patent or technology purchasing to externally source technology.

Regarding the final decision making, our findings confirm earlier findings that corporate management makes the final decision about the external or internal acquisition of technological knowledge, e.g. as brought forward by Brem [2007] or Thom [1980]. In our study, almost half of the companies use a centralized board of the top management, which confirms the assumption. However, our results also show that in pioneer companies, top management is more often involved in the decision process than in follower companies.

As the study is limited to German companies, the findings can probably not be generalized for other countries. However, nowadays the size of a company in terms of sales or employees is not the single indicator for being globalization anymore. Even SMEs may have international activities, e.g. through partners. Another limitation results from the broad range of different industry sectors in our survey. The findings of the survey remain tendency statements as the differences identified are based on an explanatory approach, only presenting descriptive findings. In addition to that, the study has just 71 participants, and more specific statistical analyses could not be applied. Hence, further research should quantify the differences, e.g. by hypothesis testing.

However, some implications for theory and practice can be identified, which we will discuss in the following. Companies base their decisions in favor of internal or external sourcing on multiple weighted criteria with scoring models and, even more commonly, with portfolio matrices. These results are not surprising but support the relevance of the discussed model by Roberts and Berry [1985] or Hermes [1995]. Regarding the researched competitive strategies, differentiators more often use channels of acquisition which offer them full and exclusive access to technological knowledge by, e.g. buying the technology, or the company. Therefore, it is possible for them to use a technology, e.g. as a unique product feature, which is a goal implied by the strategy type. Cost leaders, on the other hand, stated that they tend to prefer joint ventures, which can be seen as less cost extensive than an in-house development project. However, knowledge created by a joint venture must be shared.
with the other partner. Differentiators also more often involve the patent and legal department in the acquisition decision process, which also underlines the focus of this strategy, to ideally be the only one on the market to have a certain unique technology, which of course goes along with proper protection. Cost leaders more often involve the production department, which might be especially necessary when a new production technology is used to reduce costs. Regarding followers in comparison to pioneers, it is notable that they more often use R&D by supplier and patent or technology purchasing, which is comprehensible regarding the proposed intention to avoid R&D costs. Overall, the proposed theoretical characteristics of the different technological and competitive strategic focuses by Porter [1985] are therefore confirmed by the results of our study.

Almost half of the companies interviewed use centralized boards for the decision making process; however, the other half handles this process in a decentralized manner. It is astonishing that just a small minority of companies involve people from controlling and legal departments — with the exception of companies pursuing a pioneer strategy. Hence, independent of the fact that these results cannot be generalized, it must be stated that further research is necessary to examine why the integration of these important functions has not been accomplished yet — and what followers may learn from pioneers in this regard.

To sum up, we suggest these five propositions:

(i) Technology sourcing decisions must be based on a structured process. For this, multiple decision support systems with portfolio models are common.
(ii) The decision making process can be successful either centralized or decentralized.
(iii) Differentiators prefer acquisition strategies based on professional legal support to get full and exclusive access to new technologies.
(iv) Cost leaders are focusing on joint ventures with a strong orientation on production technologies and fast time-to-market.
(v) Followers rely more on R&D by suppliers and externally purchased knowledge than pioneers.

As already stated above, further research should explore the differences in more detail to see whether differences between strategy types are significant or not. Also, differences between the industries and whether those differences depend on the complexity or familiarity of the technology could be researched. Furthermore, an industry-specific comparison (within an industry and between different industries) should be included to find out if our results vary within different industries. Finally, it could be researched how the intentions of the buying and selling companies interact.

References


**Appendix A**

**Questionnaire**

- Which of the following statements describes your competition strategy best?
  
  (i) We cover a broad market segment, in which we offer standardized products with low or medium prices and produce these products with the lowest costs in our industry.
  
  (ii) We cover a broad market segment, in which we offer premium and unique products with high prices.
  
  (iii) We cover a narrow market segment, in which we offer standardized products with low or medium prices and produce these products with the lowest costs in our industry.
  
  (iv) We cover a narrow market segment, in which we offer premium and unique products with high prices.

- Which of the following timing strategies for technological innovations fits best to your company?
  
  (i) We strive to be the first provider of technological innovation on the market (pioneer).
  
  (ii) We first wait and follow the pioneer shortly (early follower).
  
  (iii) We wait and enter the market later (late follower).
• Which of the following modes of external technology sourcing are used by your company?\textsuperscript{a}
  (i) Licensing
  (ii) Component delivery by suppliers
  (iii) Patent or technology purchasing
  (iv) Company acquisitions
  (v) Joint research alliances
  (vi) Research in joint ventures
  (vii) Contract research by external companies
  (viii) Contract research by universities/research facilities
  (ix) Contract R&D by suppliers

• Representatives of which functional departments are involved in the technology sourcing decision?
  (i) R&D
  (ii) Production management
  (iii) Sales and marketing
  (iv) Controlling
  (v) Procurement
  (vi) (Patent) Legal department
  (vii) Executive management
  (viii) External experts

• How is the technology sourcing decision operationally organized in your company?
  (i) We have one centralized board which deals with the sourcing decision.
  (ii) We have several hierarchical boards which deal with the sourcing decision.
  (iii) We have several boards on the same hierarchical level which deal with the sourcing decision.

• What methods and approaches are generally used to support the technology acquisition process?
  (i) We use portfolio or matrix designs as visualization tools to support our decision making.
  (ii) We use a scoring model such as the use-value analysis, which takes several variables into account for the decision.
  (iii) We predominantly use transaction-costs-oriented methods for the decision making.

• Furthermore, some general information on sales, employees and industry was collected.

\textsuperscript{a} Answers from “being used made positive experiences”, “being used, made negative experiences”, “is an alternative, has not yet been used” to “is not an alternative”.
Biography

**Alexander Brem** received his diploma in Business Administration and Ph.D. from the University of Erlangen-Nuremberg in 2004 and 2007, respectively, where he works as Professor of Idea and Innovation Management since 2011. Moreover, he is Founder and Partner of VEND Consulting GmbH, Nuremberg. His current research interests include technology and innovation management as well as entrepreneurship.

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