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Patent portfolio analysis as a useful tool for identifying R&D and business opportunities—an empirical application in the nutrition and health industry

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Abstract

Computer aided patent portfolio analysis is a useful tool to evaluate both the R&D landscape and business opportunities. All necessary patent data can be generated from publicly accessible data bases. Patent data allow conclusions about a firm's patent activity and the quality of its patent portfolio. Further, the international and technological scope of a company's patent strategy can be assessed. This information is particularly interesting for the evaluation of a firm's innovative potential. Besides, it allows conclusions to be drawn on the innovative dynamics of the considered market segment, in this case dietary supplements. The results are shown in graphs and spider charts. In sum, we can make conclusions about the relative innovative power and patent strength of a company within the selected market segment. We draw conclusions on the importance of patents as a method of knowledge protection in this market and gather insights about the availability of companies that are potentially suitable for co-operations or acquisitions.

Keywords: Patent portfolio; Patent analysis; Company acquisitions; Patent licensing; Infringement; Dietary supplements

Introduction

The reader is invited to imagine a company that intends to act in an area of business that is new to the firm. Naturally, such an intention involves a great number of risks that need to be minimised as far as possible in the preli- minary stages. A thorough analysis of the operating environment and the company's own possibilities are indispensable and thus need to be mentioned first and foremost. Will the market segment prove to be profitable in the long run? Can the company's own established products or the ones that are already in the R&D pipeline satisfy the requirements of the market, or is it necessary to develop new products or to include them into the company's portfolio by licenses or co-operations? Much market data may be collected by the company itself or, alternatively, be purchased from respective commercial suppliers, or the company may commission the data collection. In many cases it will be reasonable to involve external expertise either by consultancy contracts or simply by poaching suitable experts. However, this way a number of questions will remain unanswered. For example, these include an estimate of which course R&D may have to take in the considered market segment, how the evolution of potential competitors and customers may unfold, and what partners may be considered for reasonable acquisitions or co-operations. It is a fact that a large part of this information is available for free and virtually waiting to be pieced together like a jigsaw puzzle. We are talking about patent information that can be retrieved via databases. The aim of this paper is to show on the basis of a concrete example, how the systematic selection and evaluation of patent information may contribute to the assessment of new business opportunities. This paper is a subsequent practical application of a

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general framework developed to use patent information for strategic business planning [1].

1. Patents as a valuable source of information

What options do we have to get information on the trends in the fields of research and development? If we ask a scientist this question, he would usually refer to the exchange of experience in the ''community'', to lectures, symposia, the personal contact with colleagues and their publications in relevant professional journals. Surprisingly, they would, as a rule, mention the study of patent literature only considerably later. A survey by the European Patent Office assumes that there are currently approximately 4,000,000 patents in force world wide, which are joined by 700,000 new patent applications each year [2]. Further enquiries often reveal that the reason for the rather secondary use of patents as a source of information is that patents would often not prove to be sufficient or not reproducible at all, and would furthermore only allow a temporally immensely delayed perspective on the R&D landscape because of the 18 month time period between the priority date of application and publication.

In terms of insufficient reproducibility of individual patents, this opinion may be absolutely correct. However, usually this problem is restricted to a concrete individual case and has nothing to do with the value of patent information as a whole in view of the virtually inconceivable wealth of information. In the end we ought to consider that the proven insufficient reproducibility both of a patent application and a granted patent has the ultimate consequence that the right of prohibition, which has been aspired at high expense, is either not generated, or revoked, or can simply not be enforced. According to estimations by patent attorneys it can be assumed that, after all, currently 10% of the human knowledge is protected by patents, of which 20–25% at the most have not proven to be legally valid in the last consequence [3]. From this it follows that more than 3,000,000 patents are currently in force world wide, which do not only fulfil the international requirements of novelty and inventive activity, but which also communicate a—as the skilled person puts it—''reproducible technical teaching''.

Also, the argument of the 18 month delay after which the information is made known to the public, cannot be sustained on closer consideration. Generally, patents are not filed when a development has been finished, but at a much earlier point in time. This procedure is a strategic necessity as it is the only way to protect a both cost-intensive and time-intensive development from the beginning, and to prevent, if possible, R&D investments from proving successful but worthless in the end as the competition have filed their own intellectual properties perhaps only a few days earlier. If we further take into account that a researcher—particularly if he comes from an industrial enterprise—would not report the latest development results before research has been finished and the product has either been launched on the market or disappeared. Patent applications, much to the contrary, does very well offer a very prompt insight into the research strategy of a company despite of its 18 month delay.

2. Utilisation of patent information

The following quotation stems from the Austrian economist Schmookler: ''*We can choose whether we wish to use patent statistics with prudence and to learn what we can learn from them, or not to use them and to do without all the information that they alone can provide*'' [4]. Yet before search and evaluation of information start, the task must be clearly defined. The objective and the example that this paper is based on, consists of:

- dealing with the field of Dietary Supplements,
- establishing the most active companies,
- finding out the companies with an extraordinary patent position, and
- deriving proposals from the data thus gained, which companies or institutions would be suitable for co-operation or acquisitions in order to sensibly complement the R&D pipeline of a fictitious company that plans to get into this field.

The first step in an evaluation of patent information obviously is to carry out a respective search. Referring to the present issue, both advantages and disadvantages are showing: it is certainly an advantage that—in contrast to, e.g. a product release—completeness of the search is not of superior significance. However, a considerable disadvantage is that the area of ''Dietary Supplements'' is so extensive that we receive high five digit number of ''hits'' as a result. Yet in principle an exhaustive data base is desirable in order to achieve meaningful results. If there are too many documents involved in the evaluation, we are running danger that we do not receive significant results but just generic conclusions of no significance whatsoever. Therefore, the art of the game is to formulate the question in the search intelligently so that the amount of data lies within a spectrum between at least 50 and at most 2000 documents.

For this reason, we carried out not only one search dealing with Dietary Supplements in the present case but in addition, we divided the field into groups, so-called technology fields, for each of which we carried out an individual search. Selection and shape of such fields are left to the analyst and essentially conform to the individual requirements. A list of keywords is needed for each of the individual searches, unless we directly use the international classification of protective rights, namely the IPC classes. In the present case we divided the area of Dietary Supplements into 12 technology fields according to the relevant IPC classes (cf. Table 1).

In every search there is the problem that protective rights can be allocated to more than one technology sector.

Table 1
Technology fields for the area of Food Supplements

IPC	Description
A23L 001-22	Spices, flavouring agent or condiments; artificial sweetening agents; table salts; dietetic table substitutes
A23L 001-226	Synthetic spices or flavouring agents or condiments
A23L 001-235	Fruit flavours
A23L 001-236	Artificial sweetening agents
A23L 001-275	Addition of dyes or pigments without optical brighteners
A23L 001-28	Edible extracts or preparations of fungi
A23L 001-29	Modifying nutritive qualities of foods; dietetic products
A23L 001-30	Dietetic products containing additives
A23L 001-302	Vitamins
A23L 001-303	Vitamins A or D
A23L 001-304	Inorganic salts, minerals, trace elements
A23L 001-305	Amino acids, peptides or proteins

If we make do without a clear differentiation and allow multiple entries, the amount of data increases while the content of information does not grow. For this reason, it is usually recommendable to evaluate every protective right within one field of technology only. In a key word search this is not easily possible as the evaluation would need to be carried out individually on the basis of claims or abstracts. Here, a search according to IPC classes proves to be an advantage again, because an allocation can be carried out automatically if we start from the main class. The number of mistakes within the IPC Classification usually is not larger than within a selection of protective rights classified by individual experts, and with a large amount of data it is therefore even more irrelevant for the final conclusion.

Ultimately, the searched data can only be as good as the database the information is taken from. In principle, Derwent Information World Patent Index (WPI) is naturally considered a suitable database; satisfactory results are, however, also achieved with data collected from the databases of MicroPatent or Delphion. In the end, this means that we will choose the databases according to the best offer made regarding kind and scope of the search.

3. Evaluation of patent information

3.1. Competitor monitoring and technology assessment

The benefits of patent information for the evaluation of developments in the area of R&D have been shown empirically in a multitude of studies [5–7] which goes particularly for innovative technologies and technologies that are still in the beginning of their development, for example the production of nano-materials [8]. A particularly interesting application in this field is the combination of market and patent information, which, e.g. allows us to check whether the adopted R&D strategy is in line with the market attractiveness of the developed and patent protected products [9].

Table 2 summarises a set of indicators which have been found useful to analyse the patent strategy of a company. All indicators show the highest level of information if their dynamic development over time is monitored [10].

A company's patent activity in certain technological areas, for example, is a fundamental indicator. Any sharp increase or decrease can be regarded as a change in R&D activity and focus, and may therefore have a technological and commercial impact in the future. The "technological share" based on patent applications, measures a company's competitive position in a technological field. Conceptually, the technological share captures the competitive position in R&D, as does the market share in the marketing domain. A significant drop in the value of this indicator should lead to a re-assessment of its R&D strategy [11]. "R&D emphasis" illustrates the importance placed on a specific technological field within a company's R&D portfolio and highlights differences in a firm's R&D strategy.

3.2. Patent quality and patent strength

The worth of patent information is significantly enhanced if varying levels of patent quality are taken into account. Literature suggests the following indicators for measuring the quality of a patent or a group of patents [12]:

- ratio between granted and filed patents [13],
- international scope [14],
- technological scope [15], and
- citation frequency [16–19].

In order to verify these indicators of patent quality and to determine their respective weights on an empirical basis, a 4-step-algorithm is proposed [1]:

Step 1: Calculation of numerical indicators for each patent application (e.g. patent granted yes/no; size of patent family based on the total number of members, citation frequency, etc.).
Step 2: Calculation of relative patent indicators to eliminate systematic distortions (e.g. relative citation frequency).

Table 2
Important patenting indicators for competitor monitoring

Patent indicator	Definition	Meaning
Patent activity (PA_{iF})	Patent applications (PA) of a company in a technological field (TF)	Extent of R&D expenditures of firm I in TF
Technology share	PA_{iF}/PA of all companies in TF	Competitive technological position of a company in TF
R&D emphasis	PA_{iF}/number of companies (i) total patent applications	Importance of technological field F for a company
Co-operation intensity	Number of joint patent applications with co-applicants in TF	Access of a company to external knowledge
Share of granted patents (Q_1)	Granted patents of a company in TF	Technological quality of a company patent applications
Technological scope (Q_2)	Diversity and number of IPC classes in companies patent applications	
International scope (Q_3)	Size of patent family and share of triad (US, EP, JP) patents	Economic quality of a company patent applications
Citation frequency (Q_4)	Average citation frequency	
Average patent quality (PQ_{iF})	Sum of all indicators of patent quality (Q_1–Q_4)	Average total quality of all patent applications of a company in TF
Patent strength (PS_{iF})	*Product of average patent quality* (PQ_{iF}) and patent activity (PA_{iF})	Technological strength of a company in TF
Technology share	PS_{iF}/PS of all companies in TF	Competitive technological position of a company in TF (qualitative)
Relative technology share	PS_{iF}/Max. patent strength of a company in TF	Distance of a company to the technological leader in TF

Source: [1].

Step 3: Identification of a sample of economically very important patents in the portfolio (e.g. based on the subjective vote of a panel of experts being familiar with the particular technology field).
Step 4: Statistical comparison of the generated sample portfolio with a randomly selected control group from the selected technology field portfolio.

In practice, the information contained in a patent document, e.g. from WPI, is converted into numerical indicators of potential interest. Subsequently, relative patent indicators need to be calculated in order to avoid an unwanted distortion. For example, the "citation frequency" of a patent is seriously influenced by its age. In order to assign a systematically higher weight to older patents, the citation frequency of a patent needs to be measured in relation to the citation frequency of an average patent of the same year [20,1], e.g. by introducing a kind of "impact factor" which gives more weight to the citations received in the last two years. Thirdly, a sample of economically important patents and a comparable and randomly chosen control group of patents is selected. Finally, a logistic regression analysis is carried out in order to test differences between both groups according to the defined set of quality indicators. As a result one observes quality weights for each patenting indicator which can be used for calculating an overall index called "average patent quality" for each patent. This value, however, is solely linked to the commercial value of the patent since it does not provide any information concerning its enforceability and legal value as a prohibition right.

Once the patent quality is determined, the "overall patent strength" can be determined. A better measure of technology share including aspects of patent quality can be derived for each technological field in a similar matter as described above. It shows the competitive position of a company in a concrete technology field. That is why this indicator has been proposed as a core element of balanced score cards for controlling purposes. The "relative technology share" transforms the technology share into a range of values between 0 and 1; this facilitates the identification of leading companies and the assessment of technological distances between competitors.

4. Analysis of the results

In the following, we will exemplarily present just the results of the aggregated analysis; these allow basic conclusions on the patent situation in the surveyed market segment. A detailed presentation of the individual fields of technology according to Table 1 may obviously be carried out in the same way and would make sense if specific conclusions about the situation in a particular subsegment are needed.

4.1. Patent activity

The market segment of "Dietary Supplements" has registered a substantial increase in annual new patent applications since 1994.[1] When the number of patent applications was well below 500 in the beginning of the 1990s, an annual increase of at least 20% has been registered since that time;

[1] We use the number of patent families as an indicator of patenting activity. The share of granted patents in a patent family is taken as a quality indicator for the respective patent family.

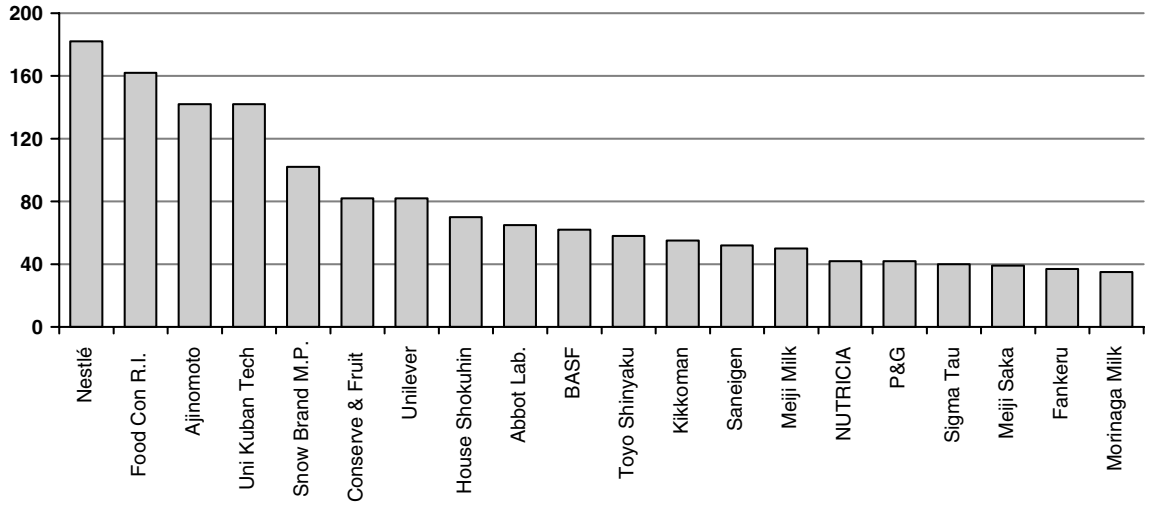

Fig. 1. Patent activity of the Top-20 within the market segment "Health Nutrition" based on total number of patent families within the period 1994–2002.

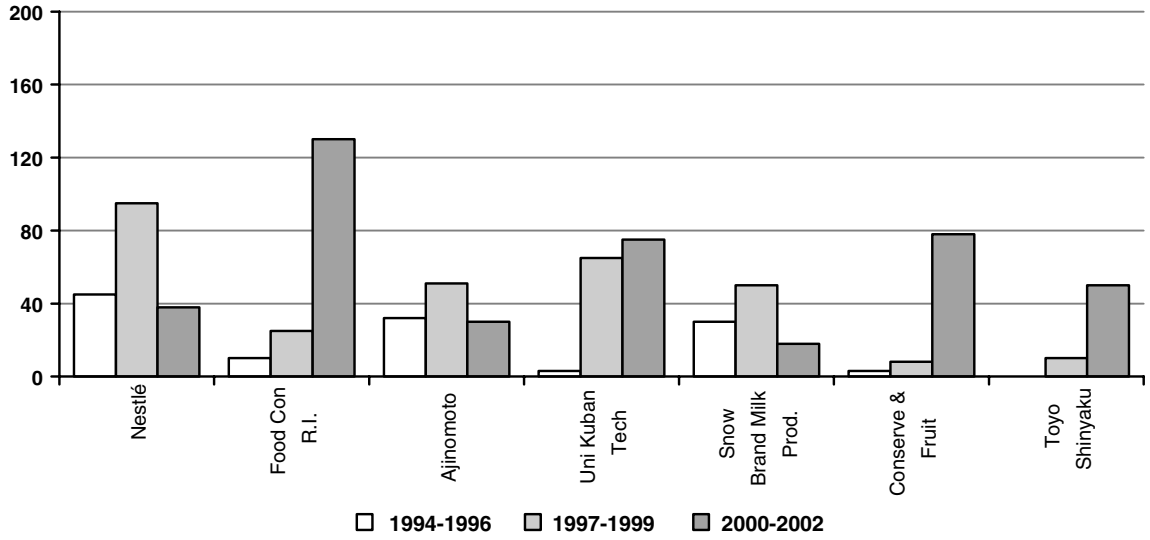

Fig. 2. Dynamic of the patent activity of the Top-7.

in 2001 the number of applications was at around 2500 per annum.[2] Therefore, just a first glance on the dynamics makes it clear that we are dealing with a very active and thus an attractive field. All in all, the search included approximately 10,500 documents, in which most applicants, however, owned only one or two protective rights. The number of applicants with more than 10 entries was below 100, which makes clear that this segment is not only very dynamic, but also extremely fragmented. Fig. 1 gives an overview of the Top 20 applicants wherein the base number consulted was exclusively the patent activity, i.e., the number of published protective rights in the period from 1991 to 2003.

This simple overview already contains the first surprise. It was to be expected that worldwide acting food producers like Nestlé and Unilever that are also well-known to the non-expert, are among the Top 10. However, it is certainly surprising to find three Russian research institutes in the same group as the class winner Nestlé—the Food Conserve Research Institute, the University of Kuban, and the Conserve and Fruit Drying Institute, which together hold more than twice as many protective rights as Nestlé. Furthermore, it was not to be expected that there were ten Japanese companies among the Top 20. However, as only the priority-establishing applications were counted in this overview (for a number of reasons, particularly in Japan there is the tendency to make 10 or more patent applications out of

[2] The number of filed applications is considered to be a better indicator for the patent activity in a particular technological field compared to the number of granted patents, since behind each application stands a commercial decision to take money into the hands in order to achieve an additional protective right. On the other side, the grant of a patent is solely subject to patent law and does not take commercial interests into account.

a single invention), it is necessary to have a closer look at the application behaviour. Here, the question is which period the application behaviour can be linked to, or in other words, if we are observing a current or a finished development. The dynamics of the application behaviour are given in Fig. 2.

Therefore, the top position that Nestlé holds in this market segment, is essentially based on the application numbers of the years from 1997 to 1999, while in the past three years a noticeably decreased activity could be registered. In contrast, the number of applications that have been published in the name of the three Russian research institutes has sharply risen since the year 2000, however, they are still exclusively restricted to Russia. In comparison with this, the application behaviour of the three Japanese companies in the top group is inconsistent.

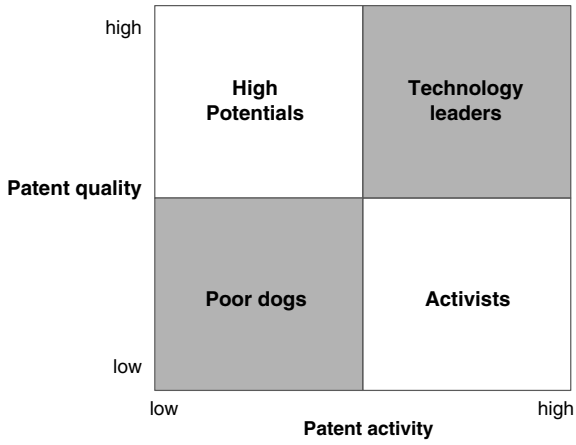

Fig. 3. Patent activity and patent quality.

4.2. Patent quality

As already illustrated in the previous chapters, patent activity is certainly an important factor to describe the innovative power of a company, but is not solely decisive. The parameters of patent quality and patent strength are equally significant. The interrelation between patent activity and patent strength is given in Fig. 3.

Technology leaders usually distinguish themselves not only by possessing the highest patent *activity* but also the highest patent *quality*. Astonishingly, according to this, companies with a high patent quality but lower patent activity (“High Potentials”) prove to be more successful on the market than those that focus on mass instead of class (“Activists”) [14]. The evaluation of the quality of the protective rights in the considered technology field is therefore equally indispensable in order to come to a meaningful analysis.

As already explained in the previous chapter, several features are necessary to compile the sum parameter of patent quality, including the rate of granted patents, the international scope of the patent family (usually applied to the triad consisting of Europe, the USA, and Japan,[3]) the technological scope (applied to the number of IPC classes the protective rights have been allocated,[4]) and citation frequency in examination proceedings weighted over time.[5] The product of patent activity and patent quality is ultimately referred to as patent strength. Fig. 4 shows the patent quality of the Top 20 companies in the market segment of Dietary Supplements in which the order which has resulted in the consideration of the patent activity, has been kept for better illustration.

Surprisingly, among the Top 10 companies there are only 6 that show a patent quality that lies above the average of 0.54, in which the protective rights of Abbot which occupy only rank 9 in patent activity, are at approxiamately 90% above-average with a value of almost 1.2, and they even show a head start of 40% compared to the following companies Nestlé and Unilever. Compared to this, the quality of the protective rights of the three Russian institutes is relatively low which can essentially be explained by the fact that they had been exclusively applied for in Russia and are therefore lacking international scope.

4.3. Patent strength

The overall “Patent Strength” of a company in a particular technological field is defined as the product of the factors “Patent Activity” and “Patent Quality” (see Table 2). Fig. 5 shows the number of patent applications and the patent strength for the Top 20 in the market segment of Dietary Supplements.

Nestlé proves to be the evident technology leader in this segment, as the highest patent activity is joined by an above-average patent quality. However, already rank 2 is surprisingly occupied by Abbot who compensated the comparatively low number of patent families by an outstanding patent quality; here we have the classical case of a “High Potential”. Opposed to this, “Activists” with a high application number but low patent quality only achieve lower ranks.

[3] The selected country grid depends of course on the technology areas which are evaluated and may look different for e.g. pharmaceuticals or mechanics. At least for chemistry and nutrition, however, the cited triad EP, US, JP has been found to reflect the importance of the markets adequately. For the future, however, an adjustment may become necessary by adding e.g. China and Korea. Reference is also made to ‘Knight HJ. Patent strategy for researchers and research managers Wiley, 1996’ for further discussion of patent strategies.

[4] The IPC classes represent the sole source of information concerning the number of technology areas a particular patent case is related to which can be retrieved directly from public data bases. Although the classification is not always correct it can be regarded as a qualified working hypothesis that the number of IPC classes corresponds to the technological scope of a patent application.

[5] Otherwise one would neglect the fact that an older patent has a higher chance per se to be cited than a just recently published case regardless of their importance for the technological area.

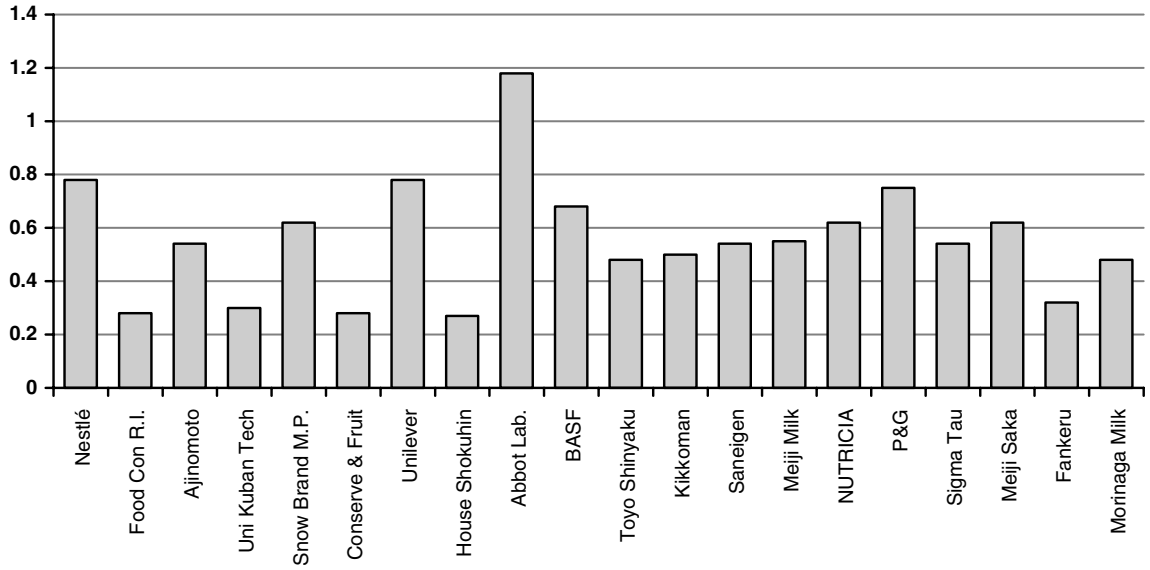

Fig. 4. Patent quality of the Top-20 within the market segment "Health Nutrition".

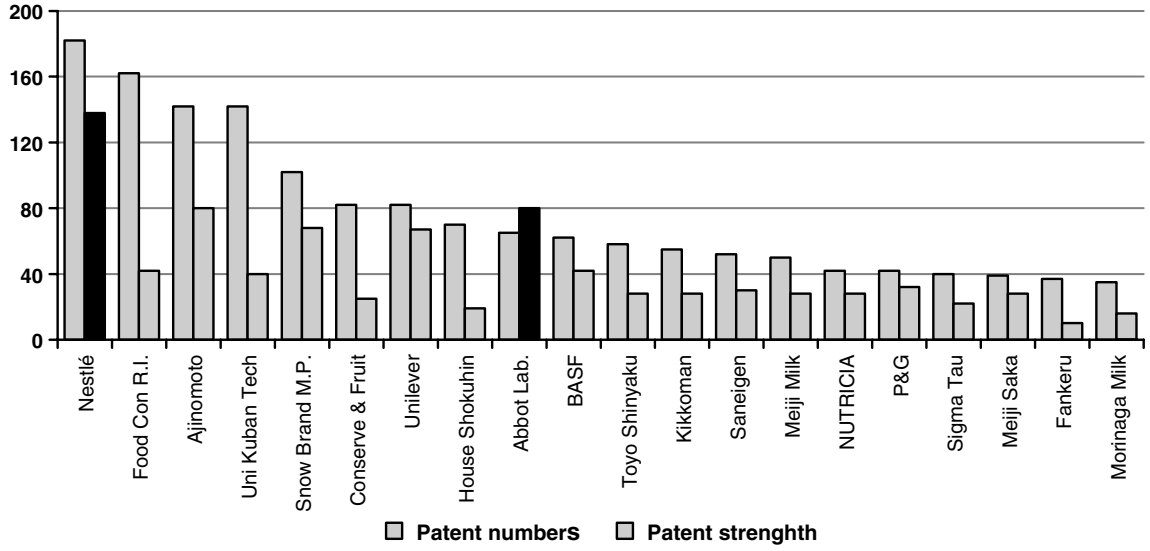

Fig. 5. Patent strength of the Top-20 within the market segment "Health Nutrition".

4.4. Presentation of the results in the spider-net

A particularly convenient presentation of the results that can be generated by systematic evaluation of patent information from data banks is the view in the spider-net as it allows the simultaneous presentation of up to five parameters. Empirically, three different spider-net views have stood the test, which are:

- quick check,
- patent strategy, and
- patent quality.

Fig. 6 shows the most important parameters that describe the patent situation for five selected companies, i.e., number of applications, average patent quality, patent strength, technology share, and frequency of co-operation. Here, the highest value which has been determined empirically is set at 100%, and all other values are related to it. Every curve in the spider-net graph connects the five parameters of each company. Ideally, a perfect pentagon on the 100% curve would result for a company that would be leading in all five parameters.

Although the practice usually looks different, Nestlé gets quite close to the ideal in the aggregated consideration of the complete market segment of Dietary Supplements: in fact, they are leading in all analysed parameters with the exception of patent quality, in which the dominating position in patent strength—as already mentioned—is essentially to be based on the high patent activity and the

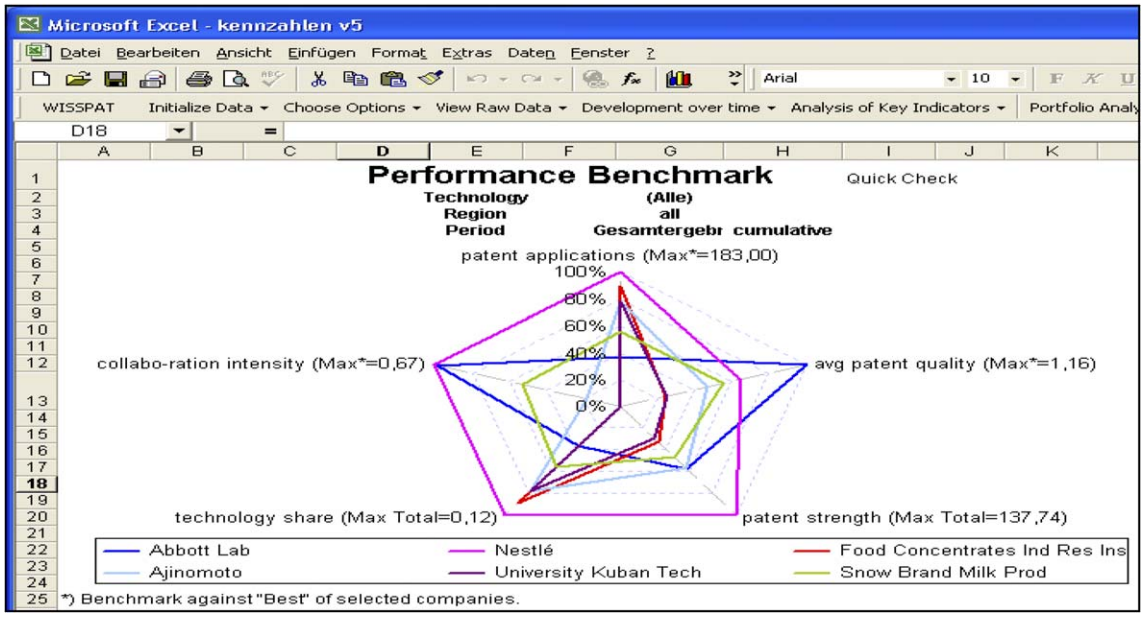

Fig. 6. Quick-check spider-net.

above-average but not highest patent quality as already mentioned. Both Nestlé and Abbot show the highest rate of co-operation. In the evaluation of this parameter, however, visual judgement is required: without evaluation by hand the software is unable to distinguish whether there was a true co-operation (i.e., more than one applicant), or if, for example, inventors were regarded as co-applicants. As a matter of principle, companies like Unilever apply in the name of at least two subsidiaries which may also simulate a co-operation activity which does not exist in reality.

Fig. 7 shows a further spider-net graph in which the parameters on the international orientation in Europe, the USA, and Japan were analysed. Data regarding the R&D activity and focus have not been included here because no sensible evaluation is possible in the aggregated presentation due to the high fragmentation of the area.

It is obvious that Nestlé in Europe, Abbot in the USA, and both Snow Brand Milk Products and Ajinomoto in Japan are the strongest representatives at 100% each. That was not to be expected any different as usually a company files a priority-establishing application in the country in

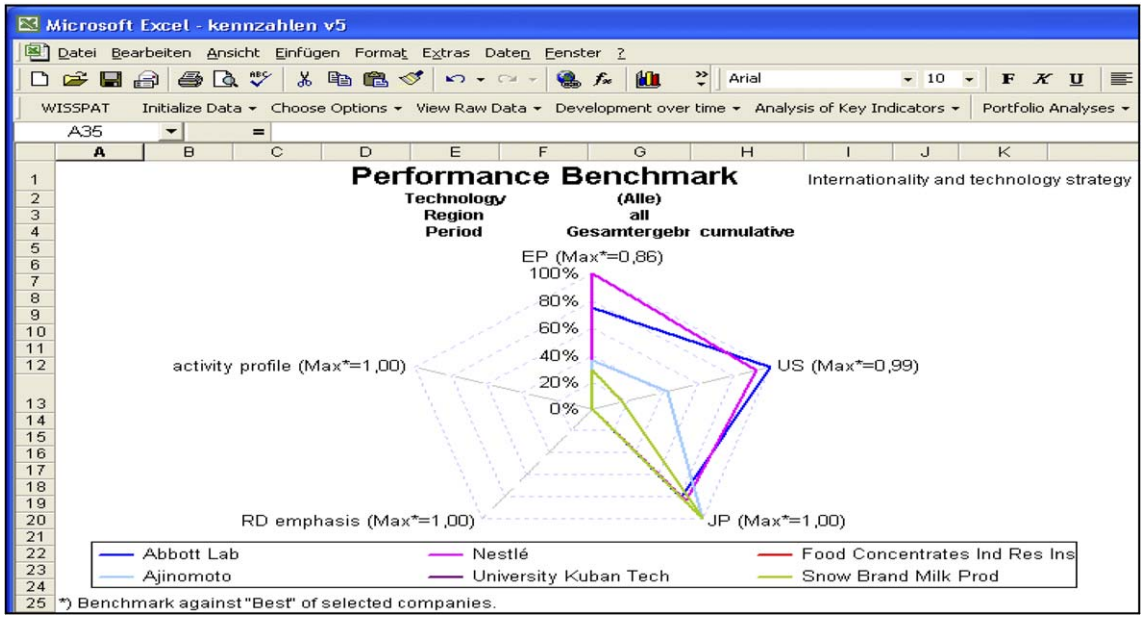

Fig. 7. Patent strategy spider-net.

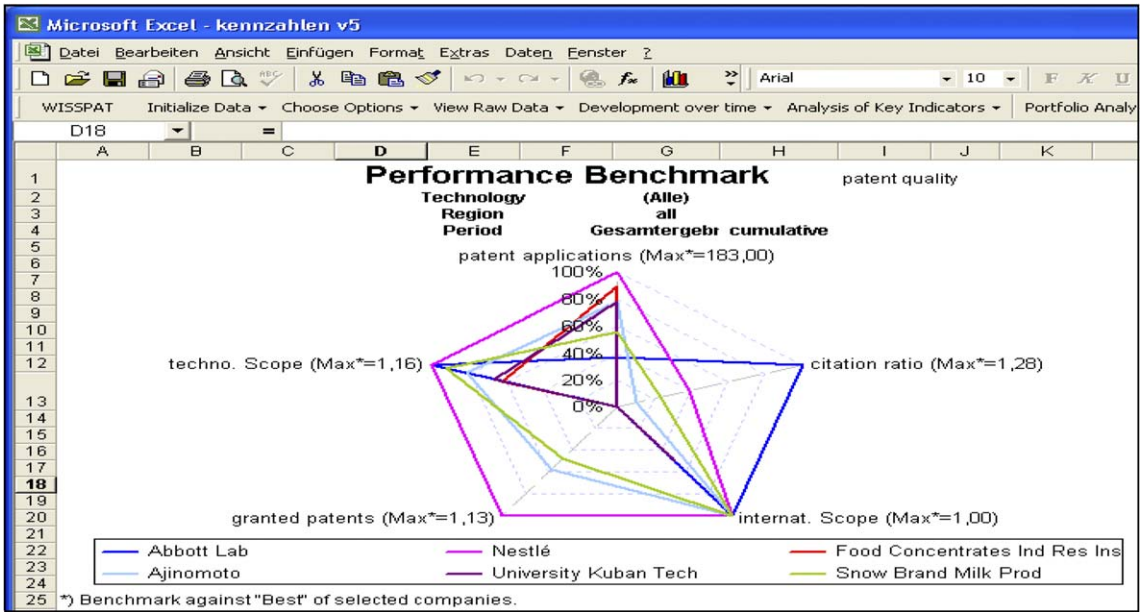

Fig. 8. Patent quality spider-net.

which it has its headquarters or a respective R&D centre. If we plan to make a statement about the international scope of protective rights and hence about the patent strategy, we will have to consider the application activity outside of this "home base". In the case of Nestlé it can be said that in more than 90% of all intellectual property families, applications were filed in the triad of Europe, the USA, and Japan, which hints that to these patents are attached a high degree of technical and strategic significance in all of these markets. The same applies to Abbot, even if the share of applications in Europe and Japan is a bit lower at approxiamately 80%. Snow Brand Milk Products and Ajinomoto also show typical application behaviour for Japanese companies: they have a high application activity which is, however, basically restricted to Japan. As most notably it is also common in the field of chemistry, there is one subsequent application in Europe and/or the USA per 10 Japanese basic applications, in which, however, 5–10 priorities are quite often combined. The reason for this application behaviour, which we Europeans find astonishing time and again, and which often leads us to premature conclusions about the innovative power of Japanese companies, is on the one hand based on the Japanese patent law, which has for a long time made relatively high demands regarding the unity of invention, and on the other hand based on the common view that a high number of patent applications would increase the glory, honour and importance of both the applying company and the inventor. We should also bear in mind that Japan has developed a booming culture of cross licensing, in which it pays to offer as many protective rights as possible for a trade-off. This goes along with a—however decreasing—tendency to settle patent disputes out of court: therefore, there are 600 patent infringement cases in contrast to 400,000 patent applications on average and 225,000 grants annually [21]. The two research institutes restricted their application activity to Russia; therefore, further evaluation has not been possible.

Lastly, Fig. 8 shows a spider-net graph on patent quality. Again, patent activity, technological scope, international scope, the number of grants and particularly the citation frequency are shown.

In view of the technological scope of the protective rights we can only detect few differences; particularly, Nestlé and Abbot are quite close to each other in this respect. This usually is a sign that all companies have been distributed an equally low number of IPC classes, therefore, there is a rather high degree of specialisation. Nestlé has the highest rate of granted patents, followed by Ajinomoto and Snow Brand Milk Products, in which the good performance of the two Japanese companies is essentially based on a high number of granted patents in their home country. Surprisingly, Abbot's rate of granted patents is very low; a closer analysis shows, however, that Abbot's applications have a high international scope, although outside of the USA most of these cases are pending under examination and have not yet become granted. Abbot's undisputed top position regarding the citation frequency is outstanding. Therefore, Abbot patents are cited as relevant state of the art in the examination proceedings more than twice as much as protective rights of Nestlé. A reason for that might be that the protective rights were applied for very early, and due to this Abbot was able to obtain basic protective rights with a broad extent of protection, which are limiting all further inventions in this area.

5. Conclusions

The analysis of the patent situation shows that the market segment of Dietary Supplements and the appending individual fields of technology have visibly increased their

dynamics particularly in the past years, which speaks for a high technical and economic importance. The patent landscape is highly fragmented, but two companies of particular significance can be identified: Nestlé dominates the whole segment because their portfolio shows the highest patent strength; this position results from the circumstance that the company—with a decreasing tendency—shows the highest patent activity in combination with a patent quality above-average and a high degree of internationality. The other company are Abbot Laboratories, that only take a medium rank regarding patent activity, but whose protective rights show the by far highest quality and citation frequency. In practice this means that a supplier of Dietary Supplements or their components would basically need to take into account the protective rights of these two companies. A further interesting finding is that among the Top 10 companies in this segment there are only companies who deliver directly to the end user, i.e., there are no producers of raw materials. Hence this market segment—if it is at all possible to evaluate it due to its strong fragmentation—is predominantly ''application-driven''. Another interesting result is that three Russian research institutes together have made more than twice as many applications as the top company Nestlé just in the past four years. The quality of these protective rights, however, is below average because they refer to Russia alone. On the other hand this means that there may be accumulated a large potential of know-how which might make the three institutes interesting co-operation partners whose patents would deserve closer examination.

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