

## **FACTORS INFLUENCING THE VULNERABILITY OF MANUFACTURERS TO PRODUCT IMITATIONS**

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### **1. Introduction**

Why do some manufacturers succeed very well in keeping their product specific know-how in-house while others struggle with this effort? The research described in this paper aims at giving an answer to this question. Why is answering this question important to manufacturers?

A relevant part of worldwide economic value is generated by selling knowledge and know-how, which only a small number or even just one company has acquired. The less companies are capable to offer demanded knowledge or know-how in a certain area and field, the more valuable it is. In many cases, the acquisition of valuable know-how comes with enormous financial efforts and only pays off if the acquired know-how can be sold profitably afterwards [Neemann 2007]. So know-how is valuable and is increasingly described as the most important resource for manufacturing companies [Fuchs 2006]. Companies and countries which are lacking know-how in certain fields try to acquire it using legal and illegal methods [Hopkins et al. 2003]. This is indirectly supported by increasing digitalization of R&D and manufacturing data and thus the increasing interlinkage of worldwide economy. For developers and manufacturers of technical goods knowing which factors influence their vulnerability to product imitations is thus crucial.

### **2. Research objectives**

This paper describes the first step in a research project visioning towards an approach of “know-how protective product design“. Companies threatened by or affected by product imitations increasingly dispose of technical measures against product imitation, supporting common measures of jurisdiction like patents and brands. Technical measures are possible in the fields of product design, manufacturing processes, logistics, and IT security [Wildemann et al. 2007]. The effectiveness of such measures has not been investigated yet and shall be clarified in later steps of this research project [Gausemeier et al. 2007, Meiwald et al. 2007]. Therefore factors and possible values for these factors must be identified that influence the vulnerability of technical goods developers and manufacturers to imitation of their products.

### **3. Research hypothesis**

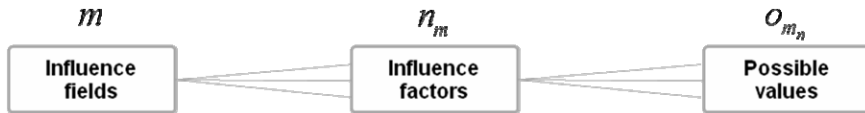
In an exploratory review of press releases and articles, seven superior influence fields on the vulnerability of considered companies to product imitations could be identified:

- Product design
- Manufacturing competencies
- Business model

- R&D logistics
- Market power
- Employee satisfaction
- IT security

In each of these influence fields, relevant influence factors and possible values of these factors can be determined (see Figure 1). Two working hypotheses serve as a foundation for the determination of these influence factors on the vulnerability of the considered companies to product imitations. These are stated below and subsequently evaluated.

1. Within the influence fields product design, manufacturing competencies, business model, R&D logistics, market power, employee satisfaction and IT security a set of influence factors and possible values of these factors can be determined by qualitative analysis of interviews with experts in considered companies.
2. The identified set of influence factors depicts all relevant influences on the vulnerability of the considered companies to product imitations.



**Figure 1. Relation of influence fields, influence factors and possible values**

#### 4. Study Design

The study described below aims at two objectives according to the research hypotheses.

1. Determine whether influence factors and according values can be determined for each of the identified influence fields stated above (influencing companies' vulnerability to product imitations).
2. Determine whether the identified set of influence factors depicts all relevant influences on the vulnerability of the considered companies to product imitations.

Therefore a three step qualitative study for the acquisition of relevant data was designed as described in Figure 2.

In the first step, press releases and articles were analyzed as well as industrial literature, which is necessary in the fields of know-how protection and product imitation as information in these fields is not published scientifically but in daily newspapers and magazines. The results of the research hypothesis were used to deduct the research hypotheses.



**Figure 2. Study design**

In the second step of the study detailed information on the seven influence factors was gathered in expert interviews with 16 senior staff of four technical goods developing and manufacturing companies. These companies sell and license products in the fields of big vessel motors, textile machinery, screens and turbines and have all experienced problems with imitations of their products in the past or currently. Interviewees work in departments relevant to the identified influence fields, as

strategic product planning, product development, manufacturing, assembly, service and maintenance, marketing and licensing. They were interviewed using a questionnaire adapted to the different departments. The questionnaire focused on the clarification of the company's (and department's) situation considering product imitations in the past, current and suspected cases in the future. Additional to the department specific questions, the questionnaire also contained a common part (list shows superordinate questions):

- How would you rate your department in a benchmark with the respective departments of direct competitors?
- Which weak points considering know-how loss and thus product imitations would you identify in your department?
- Which could be degrees of freedom to eliminate existing weak points within the scope of your department? How could these degrees of freedom be used?

The interviews were recorded and subsequently coded according to the coding scheme shown in Table 1. Coding was effectuated on two levels of analysis. Additional to the main analysis level "interview content", a discourse analysis [Foucault 1971] was effectuated in order to differentiate own opinions of the interviewees from opinions mirrored from the media. This is necessary in the context of this study as a lively public debate about product piracy took place in Germany when the study was prepared and effectuated. In this debate, some unobjective prejudice was broadcast in the media, which should be prevented from influencing the study's results by discourse analysis.

**Table 1. Coding scheme**

Analysis codes		Product design B1	Manufacturing competencies B2	Business model B3	R&D logistics B4	Market power B5	Employee satisfaction B6	IT security B7
Interview content	A1	A1B1	A1B2	A1B3	A1B4	A1B5	A1B6	A1B7
Discourse analysis	A2	A2B1	A2B2	A2B3	A2B4	A2B5	A2B6	A2B7

A list of influence factors and according possible values was generated from the coded interview fragments in the second step of the study and supplemented by a scientific literature review on the seven influence fields in the third step of the study. Further influence factors were thus identified especially in the influence fields employee satisfaction and market power.

## 5. Influence factors and possible values

The influence factors within the seven influence fields identified during the study are described below, along with possible values of the factors. The study design did not allow for a conclusion regarding the relative importance of influence fields, so the order in which the influence fields are presented is randomly.

Within the influence field product design three influence factors were identified: the level of complexity of the product, the length of innovation cycles and the problem awareness of design engineers of the company. The level of complexity of a product is described by the number of parts and by the intensity and diversity of interaction amongst the parts. In this context, a different definition seems to be more tangible: the number of competitors capable of producing a very similar product in a similar quality. This definition implies a decreasing probability of product imitations with rising product complexity since less and less potential imitators are capable of offering an imitated product with similar quality.

Another influence factor is the pace of product design. The faster a company is capable of substituting a current product by a successor, the smaller is the time slot for imitators for competing with the current original product. The successor product must offer new or additional customer benefit in this case in order to have the imitation appear obsolete. These new customer benefits can only be achieved with accordingly short innovation cycles within the company.

The degree of problem awareness of a company's design engineers has been stated in several interviews as another influence factor on the vulnerability to product imitations. A high awareness in

the product design department for their ability to influence the probability of product imitation by the way they design products and their handling of product data is believed to strongly decrease exactly this probability. Certain industry sectors with a long history of being imitated – label clothes, luxury goods and others – have started training their staff in problem awareness regarding product imitation several years ago and report on successfully having altered their product design in a way that confines product imitations. In other industry sectors – especially investment goods – imitations have just recently started to appear on important markets and staff still handles sensitive product data in a way that makes it easy for competitors and imitators to obtain that data.

Technological leadership is a central influence factor within the influence field manufacturing competencies. Companies with some unique manufacturing competencies are significantly less vulnerable to product imitations than companies that do not have such a technological leadership. Technological leadership can refer to a single manufacturing process or a unique combination of established manufacturing processes. Having a technological leadership, a company can offer products a competitor or imitator can offer not at all or only at much higher cost.

Another influence factor is the congruency of manufacturing competencies and customer benefits, i.e. The answer on the question: Am I good in the field my customers pay money for? At best, a company generates its central customer benefits by manufacturing competencies no-one else has. This makes offering an equivalent customer benefit impossible for imitators since required manufacturing competencies are missing. Inversely having technological leadership in a field without customer benefit can be answered by imitators by just substituting the required technology with another one or omit it at all.

The upgradability of manufacturing competencies is another influence factor on the vulnerability of manufacturers to product imitations. It is mainly dependent on training and experience of manufacturing staff, so companies can influence their manufacturing competencies' upgradability mainly by human resource instruments.

Within the influence field business model, the shares of sales of a company in different selling mechanisms were stated a relevant influence factor in the interviews. These different mechanisms are selling technical products, selling licenses for technical product and selling hybrid products consisting of technical goods and related services. With licensing technical products comes the obligation to make all product data required to manufacture the licensed good available to the licensee and so leave the company. Licensees themselves then hire suppliers for manufacturing licensed parts. Thus, the number of interfaces at which product know-how can find its way to potential imitators significantly rises. This effect does not occur if a company sells its products itself. Nevertheless in many investment goods industry sectors the state-of-the-art of utilized technologies is so strongly played out that imitators can imitate a product easily once they have it in hands. Linking technical products and related services – operation, maintenance or others – has been reported a good strategy in such played-out industry sectors in the interviews. Imitators willing to offer such a hybrid product consisting of technical and service benefits will have to acquire know-how, competent staff and distribution networks in both fields, which is a powerful barrier-to-entry for many potential imitators. Thereby selling hybrid products decreases the vulnerability of manufacturers to product imitations.

Out of the mechanisms selling technical products, selling licenses and selling hybrid products, many companies apply more than one. According to the above-mentioned line of argumentation the respective shares of sales in these three mechanisms influence the vulnerability of manufacturers to product imitations.

In the influence field R&D logistics, influence factors on the level of integration of a company in value creation networks are stated be relevant. In detail, these influence factors are the degree of product design distribution, the in-house production depth and the level of integration into supplier networks. For the relevance of these influence factors, the interviewees stated mainly one reason: proportionality between number and intensity of interfaces of one manufacturer with other manufacturers on the one hand and know-how-loss and product imitations on the other hand. This proportionality is especially distinctive, when these interfaces are used to share detailed information about product or manufacturing concepts, which is the case in highly distributed product design, low in-house production depth and thus high integration in supplier networks.

Within the influence field market power, technological and economic market power have to be distinguished. As an influence factor regarding technological market power the degree of technical evolution [Lindemann 2006] of the technologies used in a product could be identified. The newer those technologies are, the lower is the probability of imitations of the product is. With rising maturity of these technologies, this probability also rises. Further influence factors are size and number of fields of application of technologies mastered within a company [Gausemeier et al. 2006]. Bigger fields of application and thus markets are more attractive to potential imitators than small ones, and a high number of fields of applications increase the probability of getting in touch with imitators.

As influence factors regarding economic market power interviewees named company size, market share and profit margins relative to competitors. For those three factors, a higher value is believed to be an indicator for lower vulnerability to product imitations each. A further influence factor within the field of market power is the customer structure of a company. A large number of customers decreases the pressure to share sensitive know-how since dependence on each one of the customers is small. This pressure increases with customer number getting smaller, leading to the compulsion to involuntarily sharing product know-how.

The importance of the influence field employee satisfaction has repeatedly been stated by the interviewees. It is assumed that staff satisfied with their job is more loyal to their company and thus are less likely to consciously or unconsciously transfer sensitive product data to potential imitators. In the scientific literature review carried out after the interviews, several influence factors within the influence field employee satisfaction could be deduced. Additional to the level of staff salaries compared to direct competitors, the existence and quality of staff development measures could be identified as influence factors. Additional indicators are absence rate due to illness and the acceptance of staff development measures [Rosenstiel 2007].

Within the influence field IT security, influence factors are broadly discussed user authorizations and protection of IT infrastructure against external attacks. For the organization of internal authorizations a role based model is assumed to offer the best protection against know-how loss and thus accordingly product imitations. Against external attacks, the company IT infrastructure must additionally be secured by state-of-the-art firewall software [Wildemann et al. 2007]. Whilst in large companies these factors are normally attributed great attention, many small and medium sized companies have a lot of work to do in this field.

## **6. Results**

The result of the effectuated study is a set of influence factors on the vulnerability of manufacturers to product imitation. Additionally for each identified influence factor, possible values were assumed according to the interview content and literature review. Figure 3 shows influence fields, influence factors and possible values of each factor.

Figure 3 also shows that the study succeeded in providing a set of factors influencing the vulnerability of manufacturers to product imitation and possible values for each influence factor. Accordingly working hypothesis 1 can be considered confirmed.

Working hypothesis 2 postulates that the influence factors shown in Figure 3 represent all major influences on the vulnerability of manufacturers to product imitation. The data acquired in the study's interviews did not show up any major new influence field. Furthermore, a set of influence factor could be identified for all influence fields mentioned in working hypothesis 1. Except for influence field employee satisfaction, most identified influence factors were mentioned several times in different interviews. Accordingly the study strongly suggests that working hypothesis 2 can also be considered confirmed. Anyway, the simple listing of influence factors and possible values implies certain disadvantages, which will be reflected in the outlook chapter.

## **7. Outlook**

At the end of this research project stands a vision of “know-how protective product design”. This paper presented the first step of research work and presented a list of factors influencing the vulnerability of manufacturers to product imitations as result. In a further research step, the identified

influence factors shall be linked to possible technical and process driven measures against product imitation. For this purpose, the present list of influence factors features two major disadvantages. Up to now, there is no statement possible regarding both any kind of weighting the influence factors and dependencies amongst the different influence factors. For allowing a meaningful linking between values of influence factors on the one hand and possible measures against product imitation on the other hand, the following research step will necessarily have to be performed in this research effort:

1. Quantitative analysis of relevance (and thus weighting) of different influence factors
2. Quantitative analysis of dependencies amongst different influence factors
3. Linking of values of influence factors to possible measures against loss of know-how and thus product imitation

INFLUENCE FIELD	INFLUENCE FACTOR	POSSIBLE VALUE
Product design	Complexity of products	low medium high
	Innovation cycles	short average long
	Design engineers' problem awareness	none partially trained existent
Manufacturing competencies	Technological leadership	within reach out of reach
	Congruency of customer benefits and manufact. comp.	existent within reach out of reach
	Upgradability of manufacturing competencies	none low high
Business model	Selling technical products	low share of sales medium share of sales high share of sales
	Selling licences of technical products	low share of sales medium share of sales high share of sales
	Selling of hybrid products	low share of sales medium share of sales high share of sales
R&D logistics	Degree of product design distribution	none low high
	In-house production depth	0-33% 34-66% 67-100%
	Integration in supplier networks	none low high
Market power	Products' degree of technical evolution	new established played out
	Technologies' field of application	small medium big
	Company size	small medium large
	Market share	0-33% 34-66% 67-100%
	Number of customers	one 2 to 5 many
	Margin relative to competitors	low equal high
Employee satisfaction	Salaries relative to competitors	low equal high
	Quality of staff development measures	low medium high
	Absence rate due to illness	low medium high
IT security	Application of role based access authorizations	no partially yes
	Protection of IT infrastructure against external attacks	no partially yes

Figure 3. Influence fields, influence factors and possible values

## References

- Foucault, M., "L'ordre du discours", Editions Flammarion Paris, 1971
- Fuchs, H.-J. (Ed.), "Piraten, Fälscher und Kopierer – Strategien und Instrumente zum Schutz geistigen Eigentums in der Volksrepublik China", Gabler Wiesbaden, 2006
- Gausemeier, J., Hahn, A., Kespohl, H., "Vernetzte Produktentwicklung", Hanser Fachbuch München, 2006
- Gausemeier, J., Stollt, G., Stoll, K., "Für präventiven Schutz vor Produktpiraterie", Intelligenter Produzieren, No. 6, 2007, pp. 20-21
- Hopkins, D., Kontnik, L., Turnage, M., "Counterfeiting exposed – protecting your customer brand", John Wiley & Sons Hoboken, 2003
- Lindemann, U., "Methodische Entwicklung technischer Produkte" (2. Edition), Springer Berlin, 2006
- Meiwald, T., Petermann, M., "Technische Maßnahmen gegen Produktpiraterie", Intelligenter Produzieren, No. 6, 2007, pp. 24-25
- Neemann, C., "Methodik zum Schutz gegen Produktimitationen", Shaker Aachen, 2007
- Rosenstiel, L., "Grundlagen der Organisationspsychologie", Schäffer-Poeschel Stuttgart, 2007
- Wildemann, H., Ann, C., Broy, M., Günthner, W., Lindemann, U., "Plagiatschutz – Handlungsspielräume der produzierenden Industrie gegen Produktpiraterie", TCW München, 2007

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